CHAPTER 4

CORROSION PREVENTION AND CONTROL

As a maintenance crew member, you will work in two main areas when combating corrosion on naval aircraft. These areas include aircraft structures and avionics corrosion control.

AIRCRAFT STRUCTURES AND CORROSION

LEARNING OBJECTIVES: Describe how metal corrosion can threaten the structural integrity of an aircraft. Identify the personnel required to obtain corrosion control training. Identify the primary reason for selecting materials in aircraft construction.

Modern high-speed aircraft depend on the structural soundness of the metals that make up the largest percentage of their thousands of parts. Metal corrosion is the greatest threat to the soundness of metals and to the structural integrity of an aircraft. The materials used to construct an aircraft are designed to carry certain loads, to withstand given stresses, and to provide strength for safety. Corrosion reduces the strength and changes the mechanical characteristics of the materials, thus endangering the aircraft and reducing the margin of safety.

The corrosion that occurs on avionics equipment is similar to that which occurs on the basic airframe structure. The main difference is the amount of corrosion that is detrimental. A small amount of corrosion on avionics equipment can cause serious degradation or complete system failure. However, the same amount of corrosion on aircraft exterior surfaces might go unnoticed.

You can detect corrosion on the exterior of aircraft or equipment visually. If you follow the scheduled inspection requirements on a day-to-day basis, you will ensure adequate detection of external corrosion. It is harder to detect corrosion on the internal surfaces of an aircraft because such surfaces are not easily accessible. Thus., internal surfaces require special attention.

Corrosion often progresses unnoticed by the untrained technician. Therefore, the responsibility for the detection and treatment of corrosion on the aircraft is assigned to all work centers in each activity. This ensures that sufficient knowledge is available to perform all required inspections. Formal training in corrosion control is a requirement for ALL MAINTENANCE PERSONNEL. Through this training, maintenance personnel are qualified to perform inspections, corrosion damage repair, and corrosion prevention. The corrosion control program established by the Naval Aviation Maintenance Program (NAMP) is an ALL HANDS participation concept.

Aerodynamic efficiency is the primary consideration of a manufacturer during the design and production of an aircraft. The materials used for construction are chosen for their weight-to-strength ratio-NOT their corrosion-resistant properties. This is one of the reasons your job as a maintenance crew member is so important. When performing maintenance on an aircraft, you must constantly look for surface decay on all internal and external areas of the aircraft. You should learn the corrosion-prone areas of your activity's aircraft. Then, you can constantly inspect these areas while performing maintenance. When a new aircraft is delivered from the manufacturer, corrosion is already present. Unless this corrosion is detected and treated, it can become a serious problem that can endanger the flight safety of the aircraft.

In addition to corrosion inspection of aircraft surfaces, maintenance personnel must be equally aggressive in preventing corrosion damage to aviation support equipment (SE). This equipment keeps the aircraft flying. The reliability and effectiveness of SE also depend largely upon the structural soundness of the metals that make up its parts. SE is used in a variety of climatic and atmospheric conditions, ranging from the hot, arid desert to cold, arctic regions. In addition, the equipment is used in the salt-filled atmosphere of coastal shore bases, islands, and aboard aircraft carriers. In this environment, the sea winds carry 10 to 100 pounds of salt per cubic mile of air. These varying environmental conditions promote corrosion and alter the speed and intensity of its development. Severe corrosion can cause components or systems to fail, perhaps during critical demand times. When this happens, replacements or corrective actions are costly, time-consuming, and reduce equipment usage time. These problems can be avoided through good preventive maintenance practices and procedures.

To have good preventive maintenance practices and procedures, you must know and be able to apply the common types of corrosion prevention and moisture protecting materials.

Q1. How does corrosion endanger aircraft or reduce the margin of safety?

Q2. All maintenance personnel must be formally trained in what program?

Q3. What is the primary factor to consider when selecting materials for constructing an aircraft?

CORROSION THEORY

LEARNING OBJECTIVES: Define the theory of corrosion and its process. Identify the publications and materials used in the prevention of corrosion.

Metal corrosion is the decay of metals as they combine with oxygen to form metallic oxides. Corrosion is a chemical process that is the reverse of the process of smelting the metals from their ores. Very few metals are found in their pure state in nature. Most are found as metallic oxides. These oxides have other undesirable impurities in them. The refining process involves the extraction of the base metal from the ore. The base metal is then mixed with other elements (either metallic or nonmetallic) to form alloys. Alloying elements are added to base metals to develop a variety of useful properties. For instance. in aircraft structural applications, high strength-to-weight ratios are the most desirable properties of an alloy.

After the base metals are refined, whether alloyed or not, they have a potential to return to their natural state. However, potential is not sufficient in itself to begin and promote this reversion; a corrosive environment must also exist. The significant element of the corrosive environment is oxygen. The process of oxidation (combining with oxygen) causes wood to rot or bum and metals to corrode.

Control of corrosion depends upon maintaining a separation between susceptible alloys and the corrosive environment. This separation is accomplished in various ways. A good intact coat of paint provides most of the corrosion protection on naval aircraft. Sealants used at seams and joints prevent entry of moisture into the metal. Preservatives are used on unpainted areas of working parts. Finally, shrouds, covers, caps, and other mechanical equipment provide varying degrees of protection from corrosive mediums. However, none of these procedures will provide 100-percent protection. Weathering causes paint to oxidize and decay. Sealants may be worked out by vibration or be eroded by rain and windblast. Preservatives offer only temporary protection when used on operating aircraft. The mechanical coverings can be installed improperly or negligently.

Control of corrosion begins with an understanding of the causes and the nature of corrosion. Corrosion is the process of electrochemical or direct chemical attack on metals. The reaction is similar to that which occurs when acid is applied to bare metal. Corrosion in its most familiar form is a reaction between metal and water, and is electrochemical in nature.

The electrochemical attack involves metals of different electrical potential. These metals do not have to be in direct contact. If one metal contains positively charged ions and the other negatively charged ions, all that is needed is an electrical conductor. When the conductor is present, current will flow between the two metals, as in the discharge of a dry-cell battery. In electrochemical corrosion, the electrical conductor may be any foreign material, such as water, dirt, grease, or any debris that is capable of acting as an electrolyte. The presence of salt in any of the foregoing mediums accelerates the current flow and increases the rate of corrosive attack.

Once an electrical connection is made, the electron flow is established in the direction of the negatively charged metal (cathode). This action eventually destroys the positively charged metal (anode). Preventive measures include avoiding the establishment of the electrical circuit and removing corrosion as soon as possible to avoid serious damage. Figure 4-1 shows the electron flow in a corrosive

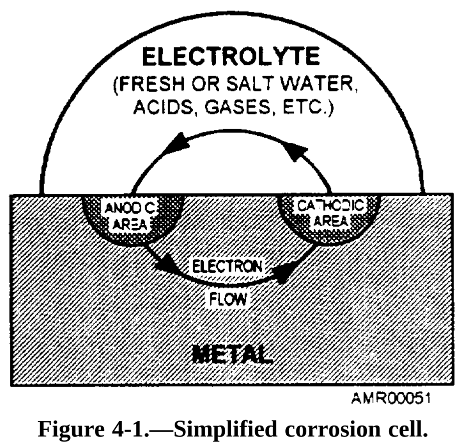


Figure 4-1.—Simplified corrosion cell.

environment destroying the anodic area. Note that the surface of a metal may contain anodic and cathodic areas because impurities or alloying constituents may have different potentials than the base metal.

Electrochemical attack is evident in several forms. The form you find depends upon the metal involved, its size and shape, its specific functions, atmospheric conditions, and type of corrosion-producing agent (electrolyte) present.

There are many factors that affect the type, speed, cause, and the seriousness of metal corrosion. Some of these factors you can control; others you cannot. Preventive maintenance factors, such as inspections, cleaning, painting, and preservation, are within the control of the operating squadron. They offer positive means of preventing corrosion.

The electrochemical reaction, which causes metal to corrode, is more dangerous under wet, humid conditions than under dry conditions. The salt in seawater and the salt in the air are the largest single cause of aircraft corrosion. Hot climates speed the corrosion process because the electrochemical reaction develops fastest in a warm solution. The warm moisture in the air is usually enough to start corrosion of the metals if they are uncoated. As expected, hot, dry climates usually provide relief from constant corrosion problems. Extremely cold climates will produce corrosion problems when a salt-laden atmosphere is present. Melting snow or ice provides the necessary water to begin the electrochemical reaction.

Thick structural sections are subject to corrosive attack because of possible variations in their composition, particularly if they were heat-treated during fabrication. Similarly, when large sections are machined or cut out after heat treatment, thinner sections have different physical characteristics than the thicker areas. Usually a difference in physical characteristics provides enough difference in electrical potential to make the piece highly susceptible to corrosion. Another factor relating to the size of materials is the relationship between dissimilar metals. (See figure 4-2.) If electrical contact develops between two dissimilar metals, the corrosion attack on the more active metal or anode (smaller size compared to the less active one) will be severe and extensive. See figure 4-2, bottom view. If the area of the less active metal is small compared to the other, anodic attack will be slight (fig. 4-2, top view).

Corrosion on avionics equipment is a continuing process. The equipment does not have to be installed, operating, or exposed to a particularly harsh environment to corrode. The rate of the corrosion process is determined by the temperature, humidity, and chemicals in the environment. Moisture is the single largest contributor in avionics corrosion. It makes little difference whether the moisture is in the form of vapor or liquid. Its affects are detrimental to metals.

A clean aircraft retains its aerodynamic efficiency and safety. Serious damage to the exterior and interior surfaces of aircraft can result from the lack of correct information about cleaning materials and equipment and their use. Shipboard procedures are not necessarily the same as procedures ashore, but the same materials are available to produce comparable results.

A problem you may face when fighting corrosion is knowing what materials to use, where to find them, and their limitations. You should use only those materials that have military specifications. Corrosion control information can be found in many directives

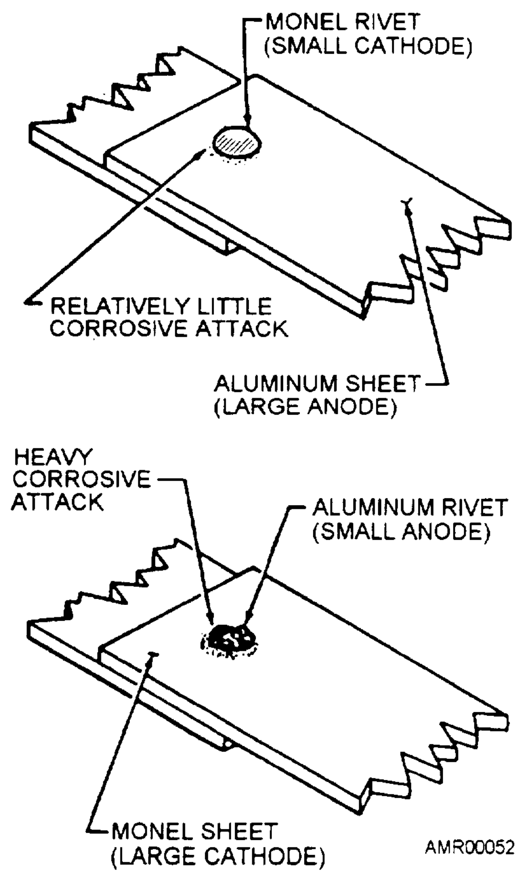


Figure 4-2.—Effects of area relationships in dissimilar metal contacts.

and instructions. This information is constantly revised to give you up-to-date knowledge and procedures. You can find the following sources of information on corrosion in your unit's technical library or corrosion control work center.

- *Aircraft Weapons System Cleaning and Corrosion Control for Organizational and Intermediate Maintenance Levels,* NAVAIR 01-1 A-509
- *Avionics Cleaning and Corrosion Prevention/ Control,* NAVAIR l6-l-540
- *Preservation of Naval Aircraft,* NAVAIR 15-01-500
- *Chart-Corrosion Preventive Compounds used by Naval Air Systems Command,* NAVAIR 01-l A-518
- *General use of Cements, Sealants, and Coatings,* NAVAIR 01-1A-507
- *Ground Support Equipment Cleaning And Corrosion Control,* NAVAIR 17-1-125
- *Corrosion Control, Cleaning, Painting, and Decontamination* (One volume of the maintenance instruction manuals (MIMs) for all late model aircraft is devoted to these subjects.)
- *Periodic Maintenance Requirements Cards*

Q4. The decay of metals as they combine with oxygen is known as what type of corrosion?

Q5. What does an intact coat of paint provide to naval aircraft?

Q6. In an electrochemical attack, electron flow is established in which direction?

Q7. How will heat, humidity, and moisture affect the electrochemical reactions that cause metal to corrode?

Q8. Why are thick structural sections most susceptible to corrosive attack?

Q9. In relation to corrosion, what affect does moisture have on avionics equipment?

Q10. Which NAVAIR publication is entitled Aircraft Weapons Systems Cleaning and Corrosion Control?

Q11. NAVAIR 16-1-540 provides what information?

Q12. Information on the preservation of Naval aircraft and aircraft engines can be found in what publication?

Q13. What information can you find in NAVAIR 01-IA-507?

PREVENTIVE MAINTENANCE

LEARNING OBJECTIVE: Define the purpose of a preventive maintenance program.

"An ounce of prevention is worth a pound of cure." Where corrosion prevention on naval aircraft is concerned, this is an understatement. Compared to the cost of naval aircraft, the cost of corrosion prevention is small. Preventive maintenance is a powerful tool that can control even the most difficult corrosion problem.

Most operating activities increase their corrosion prevention programs to meet severe conditions aboard ship. Then, these programs are decreased in scope when the aircraft is returned to the relatively mild conditions ashore. When corrosion preventive maintenance is neglected because of tactical operating requirements, a period of intensive care should follow to bring the aircraft back up to standard.

The two most important factors in preventing corrosion, and the only factors that can be controlled by field personnel, are the removal of the electrolyte and the application of protective coatings. Since the extent of corrosion depends on the length of time electrolytes are in contact with metals, corrosion can be minimized by frequent washing. Prevention also involves the correct and timely use of covers and shrouds, periodic lubrication, and the application of preservatives. Years of experience have proven the need for such measures to keep the aircraft airworthy. When corrosion preventive maintenance is neglected, an aircraft soon becomes unsafe to fly. Squadrons with the best corrosion preventive programs tend to have the best safety records, maximum use of the aircraft, and the lowest operating costs.

SUPPORT EQUIPMENT PREVENTIVE MAINTENANCE SCHEDULE

The Naval Aviation Maintenance Program (NAMP), OPNAVINST 4790.2, requires SE shops to establish a maintenance schedule for each item of equipment. The SE Custody and Maintenance History Record, OPNAV 4790/51, is used to schedule and record all corrosion maintenance actions.

SURFACE MAINTENANCE

Surface maintenance includes regular cleaning of the aircraft as well as touch-up of protective paint coatings. Since paint touch-up is done after removal of corrosion, it is discussed later in this chapter. Touch-up of new damage to paint finishes prevents corrosion from starting.

Aircraft must be washed and cleaned at least every 14 days, unless otherwise directed by NAVAIR. Aircraft must be kept in a clean condition, and repeated cleaning should be done as often as necessary. More frequent cleaning may be needed when the following conditions exist:

- An excessive amount of soil or exhaust gases accumulation within impingement areas
- Exposure to salt spray, salt water, or other corrosive materials
- Evidence of paint surface decay, such as softening, flaking, or peeling
- The presence of fluid leakage (excessive oil, coolant, hydraulic fluid, etc.)

Immediate cleaning of affected areas is always mandatory if:

- Aircraft is exposed to corrosive fire-extinguishing materials
- Spilled electrolyte and corrosive deposits are found around battery terminals and battery area
- The aircraft has been exposed to significant amounts of salt water
- Salt deposits, relief tube waste, or other contaminants are apparent
- Fungus growth is apparent
- Chemical, biological, or radiological contaminants are detected

A daily cleaning or wipe-down is required on all exposed, unpainted surfaces, such as struts and actuating cylinder rods.

Aircraft must be thoroughly cleaned before they are stored. They should also be thoroughly cleaned when they are depreserved. Unpainted aircraft are cleaned and polished at frequent intervals. Aboard ship, cleaning and removal of salt deposits are needed to prevent possible corrosion. Components that are critically loaded (designed with minimum safety margins to conserve size and weight) are cleaned as often as possible to minimize exposure to corrosive agents. These components include helicopter rotor parts and parts that are exposed to corrosive environments (such as engine exhaust gas, acid, or rocket blast).

NOTE: Postcleaning lubrication and preservation of exposed components are necessary to displace any of the cleaning solution entrapped during the cleaning operation.

Q14. What should happen to a good corrosion preventive program when carrier-based aircraft return to a shore activity after a deployment?

Q15. Operating units that have the best safety records, maximum use of aircraft, and lowest operating costs will also have what program?

Q16. At a minimum, how often must aircraft be cleaned?

Q17. List the conditions that require the affected areas of an aircraft to be cleaned immediately.

Q18. What must be done on a daily basis with unpainted aircraft surfaces and actuating rods?

AVIONICS MAINTENANCE

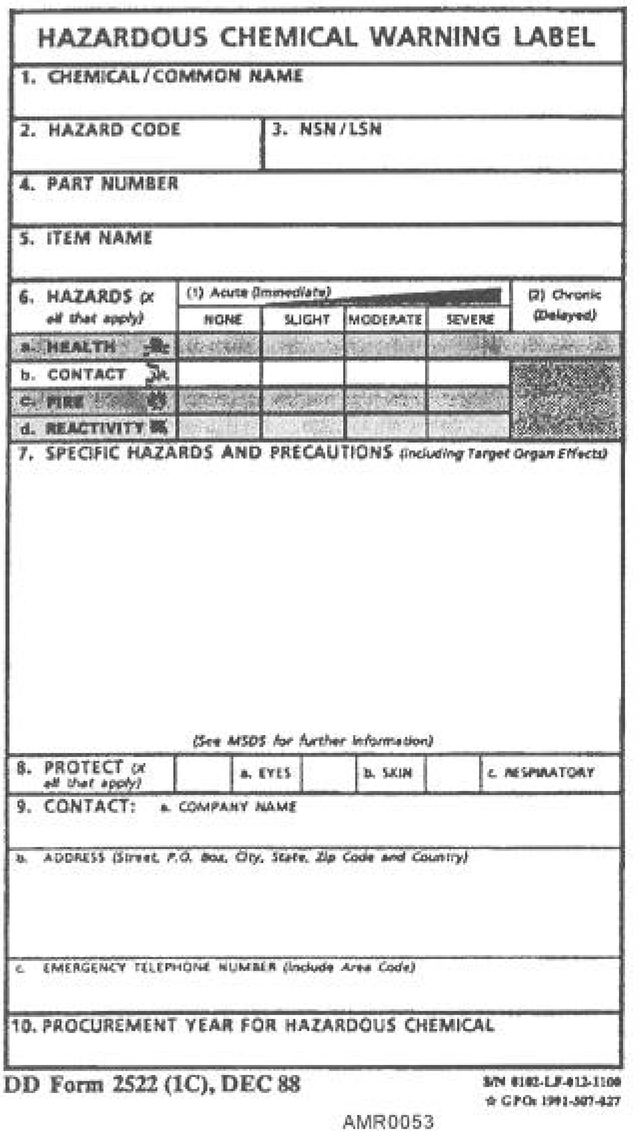
A successful avionics cleaning and corrosion prevention and control program depends upon a successful preventive maintenance program. The nature of corrosion requires that everyone involved in the repair and operation of electrical, electromechanical, and electronic systems be concerned with the corrosion control of avionic equipment. You should recognize the difference between the prevention of corrosion and the repair of damage caused by corrosion. Preventive maintenance programs at organizational- and intermediate-level maintenance activities accomplish the following:

- Reduce the maintenance time spent repairing corrosion damage
- Ensure the military avionics community is aware of the extent of the corrosion problem
- Improve avionics system reliability, durability, and service life
- Report any and every deficiency with material or process involving corrosion control

CLEANING MATERIALS

LEARNING OBJECTIVE: Identify the hazards of handling and storing aircraft cleaning materials.

When cleaning or performing corrosion control on aircraft and nonavionics aircraft components, you should use the materials listed in *Aircraft Cleaning and Corrosion Control for Organizational and Intermediate Maintenance Levels,* NAVAIR 01-1A-509. You may use materials that do not conflict with the 509, as listed in the MIM and maintenance requirements cards (MRCs) that apply. For avionics and electrical systems, you should refer to the *Avionic Cleaning and Corrosion Prevention/Control,* NAVAIR 16-l-540. Cleaning agents commonly used by O- and I-level maintenance activities are described in the following text


HAZARDOUS CHEMICAL WARNING LABEL

1. CHEMICAL/COMMON NAME

2. HAZARD CODE | 3. NSN/LSN

4. PART NUMBER

5. ITEM NAME

6. HAZARDS (x all that apply)	(1) Acute (Immediate)				(2) Chronic (Delayed)
	NONE	SLIGHT	MODERATE	SEVERE	
a. HEALTH					
b. CONTACT					
c. FIRE					
d. REACTIVITY					

7. SPECIFIC HAZARDS AND PRECAUTIONS *(Including Target Organ Effects)*

(See MSDS for further information)

8. PROTECT (x all that apply) | a. EYES | b. SKIN | c. RESPIRATORY

9. CONTACT: a. COMPANY NAME

b. ADDRESS *(Street, P.O. Box, City, State, Zip Code and Country)*

c. EMERGENCY TELEPHONE NUMBER *(Include Area Code)*

10. PROCUREMENT YEAR FOR HAZARDOUS CHEMICAL

DD Form 2522 (1C), DEC 88

S/N 0102-LF-012-1100

☆ GPO: 1991-507-437

AMR0053

Figure 4-3.—DoD Hazardous Chemical Warning Label.

CAUTION

You must read the Material Safety Data Sheet (MSDS) before you use any hazardous material.

Hazardous Materials

Hazardous material is any material presenting hazards to personnel, property? or the environment by handling, storing, and using such materials. Hazardous materials can be used safely if you take extra precautions when handling and storing these materials.

Hazardous material, such as chemicals, require a hazardous chemical or material identification label. Figure 4-3 shows a DoD Hazardous Chemical Warning Label. DoD personnel must use this label on DoD manufactured hazardous materials, repackaged containers, tanks of hazardous chemicals, and unlabeled materials already in the DoD system.

Manufacturers use various symbols and DOT shipping labels with the required Occupational Health and Safety Administration (OSHA) labeling. Used alone, these DOT symbols or labels **do not** meet the OSHA labeling requirements. Navy personnel should not place any labels on containers that already have proper labels. If you buy or receive a hazardous material with the minimum required labeling, do not add any additional labeling. If you have an unlabeled container or one with a damaged label, you can print a label from the HMIS CD-ROM or use DD Form 2522.

Flammable and Combustible Liquids

Combustible liquids are any liquids that have a flash point at or above 100°F, but below 200°F. Flammable liquids are any liquids that have a flash point below 100°F. Fire is a very serious hazard. An equal hazard to personnel is breathing poisonous (toxic) fumes in unventilated spaces.

NOTE: Flash point is defined as the minimum temperature at which a liquid gives off an ignitable vapor within a test vessel.

Solvents

Solvents are liquids that dissolve other substances. They are used in many products, such as paints, degreasing fluids, and aircraft cleaning compounds (an organic solvent). Aside from posing a fire hazard, inhaling the vapors can seriously affect the brain and the central nervous system. Therefore, you should use solvents only in well-ventilated spaces. You should wear gloves, an apron, and a face shield to protect your skin and eyes. You should also don an approved respirator to prevent breathing of the toxic vapors. Without protection, skin lesions, much like acne, may develop. If you do not use rubber gloves, your hands will lose their fatty protection and the skin will dry, crack, and become infected.

Some solvents are chlorinated. When solvents contain more than 24 percent by volume of chlorinated materials, they must be kept in specially marked containers. You must ensure the equipment in which the solvent is used is designed and operated to prevent escape of the solvent. All personnel who work near chlorinated solvents should be careful to avoid breathing the vapors. While the vapors from some solvents are more toxic than others, prolonged breathing of any fumes presents a serious health hazard.

Keep all containers holding paints, lacquers, removers, thinners, cleaners, or any volatile or flammable liquids tightly closed when not in use. Store all flammable and volatile liquids in a separate building or a flammable liquids storeroom. The approved flammable storage locker should be well ventilated. It should be located where its contents will not be exposed to excessive heat, sparks, flame, or direct rays of the sun. Storage areas must also have a fixed CO_2 or Halon extinguishing system. All electrical fixtures, outlets, and other wiring must be of the explosionproof class. Place wiping rags and other flammable waste material in tightly closed containers. You must empty these containers at the end of the work shift.

You should keep in mind that the temperature inside the paint locker could become very high, especially during the summer months. As the temperature increases, liquids expand. Maintenance personnel have received serious chemical bums on the face, hands, and arms from opening a hot can of solvent. This hazard increases many times when personnel work with the more volatile liquids, such as paint strippers. Before opening a container of solvent that has been stored in a high-temperature area, you should cool it down. You can do this by using a stream of water. Use common sense around flammable and volatile liquids.

When storing containers, you must handle them carefully to avoid breakage and spillage. If you stack the containers, the lower containers may be overloaded, causing leaks to develop along seams. This results in a loss of material. To prevent an accumulation of water and debris in their upper ends, store the containers on their sides or cover them with a tarpaulin. Before you store containers, you should inspect them for leaks and ensure complete closure of all plugs, caps, and covers. Inspect stored containers frequently for leakage, rust, or any other condition that may cause a problem. Correct deficiencies immediately.

When storing materials outdoors, you should protect the containers from the weather with tarpaulins or sheds. This reduces the likelihood of water contamination. When you use tarpaulins, lash them in place securely and position them so that air is free to circulate around the containers.

Another hazard associated with solvents (and to a certain extent with all cleaning materials) is their effect on the material being cleaned. Some solvents, such as methyl ethyl ketone and toluene, will damage rubber, synthetic rubber, and asphalt coverings. You should always consider this damaging effect when selecting cleaning materials. Most cleaning materials may do a good job in removing dirt, grease, oil, and exhaust gas deposits. However, they may also soften and ruin an otherwise good paint coating. For specific information on solvents, you should check NAVAIR 01-l A-509. Some solvents, consumable materials and their characteristics are described in the following text.

Solvent, Dry-cleaning. This material is a petroleum distillate commonly used in aircraft cleaning. It is a general all-purpose cleaner available in three types and is used for metals, painted surfaces, and fabrics. It is applied by spraying, brushing, dipping, or wiping.

Aliphatic Naphtha. Aliphatic naphtha is an aliphatic hydrocarbon product used as an alternate compound for cleaning acrylics. You may also use it for general cleaning purposes when you want fast evaporation and no film residue. Apply by dipping and wiping. DO NOT rub saturated surfaces vigorously. DO NOT use aliphatic naphtha with a synthetic wiping cloth, because it is a highly volatile and flammable solvent. Because it has a flash point below 80°F, use only in well-ventilated areas.

Safety Solvent. Methyl chloroform is for use where a high flash point is required. Use it for general cleaning and grease removal from assembled and disassembled engine components in addition to spot cleaning. Do not use it on painted surfaces. Safety solvent is not suitable for oxygen systems. It can be used for other cleaning in ultrasonic cleaning devices. Apply it by wiping, scrubbing, or booth spraying. The term *safety solvent* is derived from its high flash point. Many later-issue maintenance manuals refer to safety solvent as 1,1,1-trichloroethane.

Methyl Ethyl Ketone (MEK). Methyl ethyl ketone (MEK) is a cleaner for bare-metal surfaces and areas where MIL-S-8802 sealant is to be removed. Normally, you apply MEK over small areas with wiping cloths or soft bristle brushes.

CAUTION

Avoid prolonged breathing and skin contact of MEK. Use MEK only in well-ventilated spaces. Use extreme care when working around transparent plastics because MEK will damage them upon contact.

Trichloroethane. This is a nonflammable degreasing agent for cleaning oxygen systems equipment. It can be harmful to paint and plastic materials and since its vapors are heavier than air, it will displace oxygen in poorly ventilated areas.

Ammonium Hydroxide. Normally, you use ammonium hydroxide in the lavatories of aircraft to neutralize urine and waste products. Use a sponge to apply it, and then flush the area with fresh water.

Sodium Bicarbonate. Sodium bicarbonate also neutralizes urine deposits. You apply it with a sponge, and then flush the area with fresh water. Sodium bicarbonate is also a neutralizing agent for sulfuric acid battery electrolyte deposits.

Sodium Phosphate. Sodium phosphate neutralizes electrolyte spills from nickel-cadmium batteries. Remove spilled electrolyte immediately by flushing with fresh water. Neutralize the area by sponging generously with sodium phosphate solution and then flush with fresh water. Dry with clean wiping cloths.

Aqueous Film-forming Foam. Aqueous film-forming foam is commonly known as AFFF. Use it for removing fire-extinguishing agent MIL-F-24385 from aircraft surfaces. Complete details for the use of AFFF as a cleaning agent are in *Aircraft Weapons System Cleaning and Corrosion Control.* NAVAIR 01-1A-509.

Aircraft Surface Cleaning Compound

Maintenance personnel use water emulsion cleaners to clean aircraft. These cleaners disperse contaminates into tiny droplets that are held in suspension. The droplets of this cleaner are then flushed from the surface. MIL-C-43616 water emulsion compounds contain emulsifying agents, coupling agents, detergents, solvents, corrosion inhibitors, and water. Use these compounds on painted and unpainted surfaces in heavy-duty cleaning operations, when materials of lower detergency are not effective. Use these compounds in varying concentrations, depending upon the condition of the surface.

Apply water emulsion cleaner by starting at the bottom of the area being cleaned. You may apply the mixed solution by spraying or brushing to avoid streaking. Loosen surface soils by mild brushing or mopping. Then, give the surface a thorough fresh water rinse by using an automatic shutoff-type water spray nozzle. This type of nozzle gives hand control from a light mist or fogging spray to a full spray with high-pressure water.

Aircraft cleaning compound MIL-C-85570 is the primary cleaning compound used on naval aircraft. The five types of MIL-C-85570 are discussed in the following text.

TYPE I is for cleaning painted and unpainted aircraft outdoors or where enough ventilation is available. It may be used to clean either high-gloss or tactical paint systems.

TYPE II is for cleaning painted and unpainted aircraft indoors and in areas of limited ventilation. It is for cleaning either high-gloss or tactical paint systems. Type II is not as good as type I for these purposes. It may also be used outdoors.

TYPE III is a mild abrasive cleaner. It is used undiluted for spot cleaning high-gloss paint systems, such as exhaust tracks, shoe scuff marks, and other areas where types I and II are not effective.

TYPE IV is a spot cleaner for Tactical Paint Scheme (TPS). For spot cleaning embedded soils on TPS systems without changing the paint finish.

TYPE V is for cleaning heavy soils, such as carbonized oil, aged preservatives, grease, and gun blast and exhaust deposits. This cleaner clings to vertical oily or greasy surfaces where water rinsing can be tolerated.

AVIONIC CLEANING MATERIALS

The materials discussed in this section are the ones used most often when avionics and electrical equipment are cleaned. For a complete list, description, and application of avionic cleaning materials. you should refer to NAVAIR 16-l-540.

MIL-D-16791, type 1 detergent, is used to clean transparent plastics and glass. Also, it is used at I-level maintenance activities as a water-based solvent spray in cleaning booths and aqueous ultrasonic cleaners. For cleaning by hand, you should apply it to the area to be cleaned with a flannel cloth, let it dry, and then remove it with a flannel cloth.

Trichlorotrifluoroethane is commonly known as Freon (MIL-C-81302 cleaning compound). It is a general cleaner for avionic and electrical systems. You can use MIL-C-81302 Freon as type I (ultraclean) or type II cleaner. The uses for these types of cleaners are discussed in the following text.

TYPE I, MIL-C-81302, is used on precision equipment where an ultraclean solvent is required. It is used in clean room applications in intermediate-level maintenance activities.

TYPE II: MIL-C-81302, is used on all internal areas of avionics equipment. Normally, type II should be filtered before it is used. It can be used to clean dirt and dust from areas before soldering.

The application procedures and restrictions applying to MIL-C-81302, types I and II, are the same. They are as follows:

- Apply by wiping or scrubbing the affected area with an acid brush or toothbrush.
- Air dry or oven dry, as applicable.
- Do not use on acrylic plastics or acrylic conformal coatings.
- Do not use on unsealed aluminum electrolytic capacitors. Damage may result to end caps and cause leakage.

Isopropyl alcohol (TT-I-735) is a general-purpose cleaner and solvent. Use it to remove salt residue and contaminants from internal avionics and electrical equipment. Use an acid brush or pipe cleaner to apply a solution of isopropyl alcohol and water. Then, wipe clean and air dry.

NOTE: Isopropyl alcohol is highly flammable and requires the same handling and storage procedures as other solvents.

MECHANICAL CLEANING MATERIALS

Mechanical cleaning materials consist of items such as abrasive papers: polishing compounds, polishing cloths, steel wool, and wadding. These materials are available in the supply system. However, use them as outlined in the cleaning procedures section of NAVAIR 01-1A-509 and the specific MIM. These procedures prevent damage to finishes and surfaces. In cases of conflicting information, NAVAIR 01-1A-509 always takes precedence.

Aluminum oxide abrasive cloth is available in several forms. It is safe to use on most surfaces because it does not contain sharp or needlelike abrasives. Avoid the use of silicon carbide papers as a substitute for aluminum oxide. The grain structure of silicon carbide is sharp. It is so hard that individual grains can penetrate steel surfaces.

Impregnated cotton wadding is used to remove exhaust gas stains and to polish corroded aluminum surfaces. It is also used on other metal surfaces to produce a high reflection.

Aluminum metal polish is used to produce a high-luster, long-lasting polish on unpainted aluminum-clad surfaces. It is not used on anodized surfaces because it will remove the oxide coat.

Q19. What are the most serious hazards in handling, using, and storing aircraft cleaning materials?

Q20. Why is there a requirement to use a respirator when working with solvents?

Q21. What must be done specifically when storing solvents that contain more than 24% chlorinated materials?

Q22. Where must flammable liquids be stored when not in use?

Q23. By what means is dry-cleaning solvent applied?

Q24. Safety solvent is currently referred to by what name?

Q25. List the application procedures and restrictions that apply to ML-C-81302, types I and II.

Q26. What material must be avoided as a substitute to aluminum oxide abrasive cloth and why?

CLEANING EQUIPMENT

LEARNING OBJECTIVE: Identify the cleaning compounds used in aircraft cleaning and the procedures for washing aircraft.

Cleaning aircraft surfaces requires the correct cleaning materials and the use of properly maintained equipment. The choice of equipment depends upon several factors. Some of these are the amount of cleaning regularly performed, the type of aircraft, location of the activity, and the availability of air pressure, water, and electricity. Several types of specialized equipment are available for cleaning aircraft. These include pressure-type tank sprayers, a variety of spray guns and nozzles, high-pressure cleaning machines. and industrial-type vacuum cleaners. One piece of specialized equipment, the automatic water spray nozzle, is shown in figure 4-4.

A device used for the fast, economical cleaning of aircraft is a swivel-type, conformable applicator cleaning kit (fig. 4-5). Its design allows you to clean aircraft exteriors faster than with cotton mops or bristle brushes. Its official designation is the Aircraft Cleaning Kit No. 251. The swivel and applicator head is attached to a standard brush handle. Because it conforms to the surface, the applicator allows easier application of a constant scrubbing pressure on curved skin panels. It does this by keeping the brushes in maximum contact with the surface. When you use these brushes, you must make sure they do not cause a FOD problem.

CLASSIFICATION AND REMOVAL OF SOILS

Soils may be classified and removed as described below:

- Lightly soiled surfaces (dirt, dust, mud, salt, and soot). Use the proper mixture of MIL-C-85570 and fresh water.
- Moderately soiled surfaces (hydraulic oils, lubricating oils, and light preservatives). Use a proper mixture of MIL-C-85570 and fresh water.
- Heavily soiled surfaces (carbonized oils, aged preservatives, grease, gun blast deposits, and exhaust

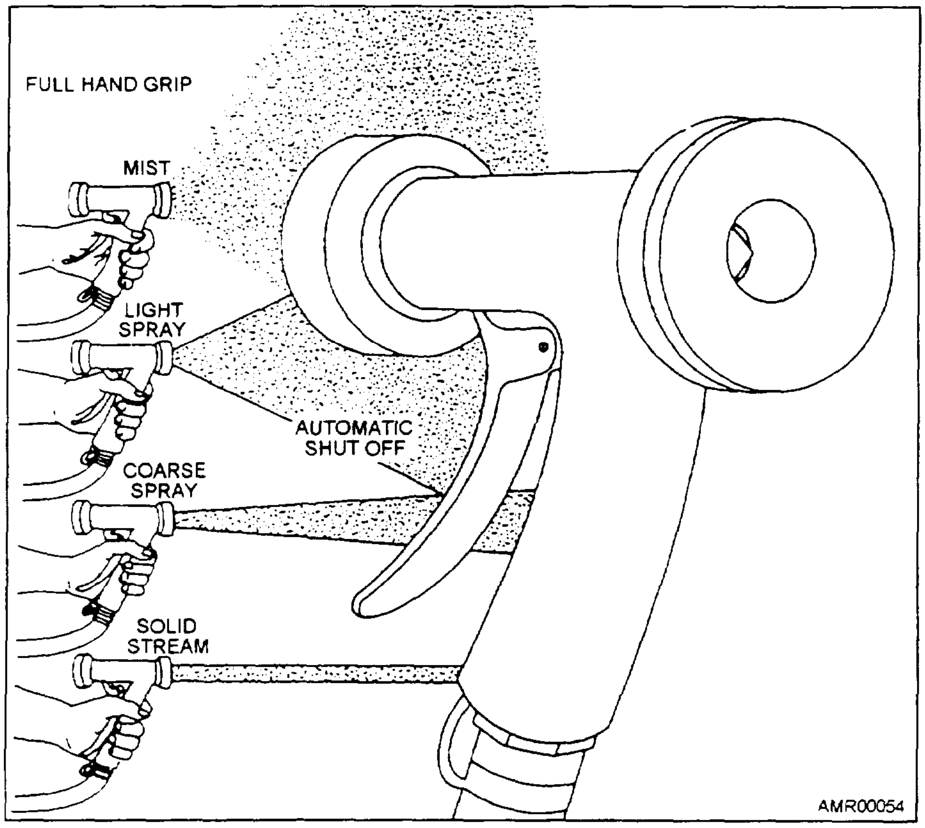


Figure 4-4.—Automatic water spray nozzle.

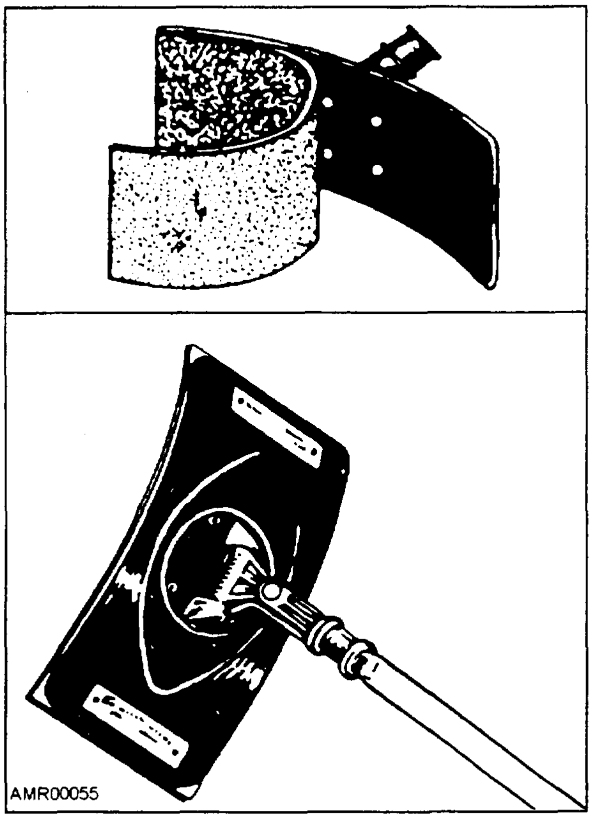


Figure 4-5.—Aircraft washing applicator.

trails). Pretreat with P-D-680, followed by cleaning with the proper mixture of MIL-C-85570 and fresh water or MIL-C-43616.

- Soiled surfaces on the tactical paint scheme (low visibility flat paint scheme). Use MIL-C-85570, types I, II, or IV for cleaning tactical paint systems according to mixture directions.

CLEANING PREPARATION

The first step in cleaning an aircraft is to select the proper cleaning agent for the method of cleaning you will use. Next, the aircraft must be prepared for cleaning.

Ground the aircraft to the deck. Static electricity generated by the cleaning operation will be dissipated through the ground wire.

If the aircraft surface is hot, cool it with fresh water before starting any cleaning operation. Many cleaning materials will clean faster at elevated temperatures. However, the risk of damage to paint, rubber, and plastic surfaces is increased. This damage is caused by the cleaners, which are concentrated by the solvent evaporating quicker at high temperatures.

Secure openings, such as canopies, doors, and access panels. Some equipment and components, such as air-sensing probes (pitot tubes), can be damaged by moisture and cleaning agents. To prevent the entrance of moisture, cover these and similar openings with either the proper aircraft cover or with masking tape, as specified in NAVAIR 01-1A-509, Appendix A.

CLEANING METHODS

There are several different methods for cleaning naval aircraft. These methods vary, depending upon the availability of fresh water.

Water-Detergent Cleaning

The water-detergent cleaning method is the preferred method for cleaning naval aircraft. Use this method when enough fresh water is available for rinsing.

After preparation, wet down the aircraft surface to be cleaned with fresh water. Then, apply a concentrated solution of cleaning compound and water to heavily soiled areas. Scrub these areas and allow the concentrated solution to remain on the surface. Limit the size of the area you are cleaning to an area that can be cleaned while it is still wet.

Next, apply a diluted solution of cleaning compound and water. The solution should be in a ratio suitable for the type of soil present in accordance with NAVAIR 01-1A-509. Apply this solution to the entire surface to be cleaned (upward and outward), including those areas previously covered with concentrated solution. The proper washing procedure is shown and described in figure 4-6.

- Scrub the surfaces thoroughly, and allow the solution to remain on the surface for 5 to 10 minutes before rinsing.

- Rinse the lower surfaces and work upward. Then rinse from the top down, starting with the vertical stabilizer, upper fuselage, upper wing surfaces, and horizontal stabilizers. Rinse lower areas in the same order and manner as the upper surfaces. If a high-pressure stream of water is used for rinsing, hold the nozzle at an angle and at a reasonable distance from the surface being sprayed. If any areas are still not clean, repeat the operation in those areas only. Thorough rinsing minimizes streaking.

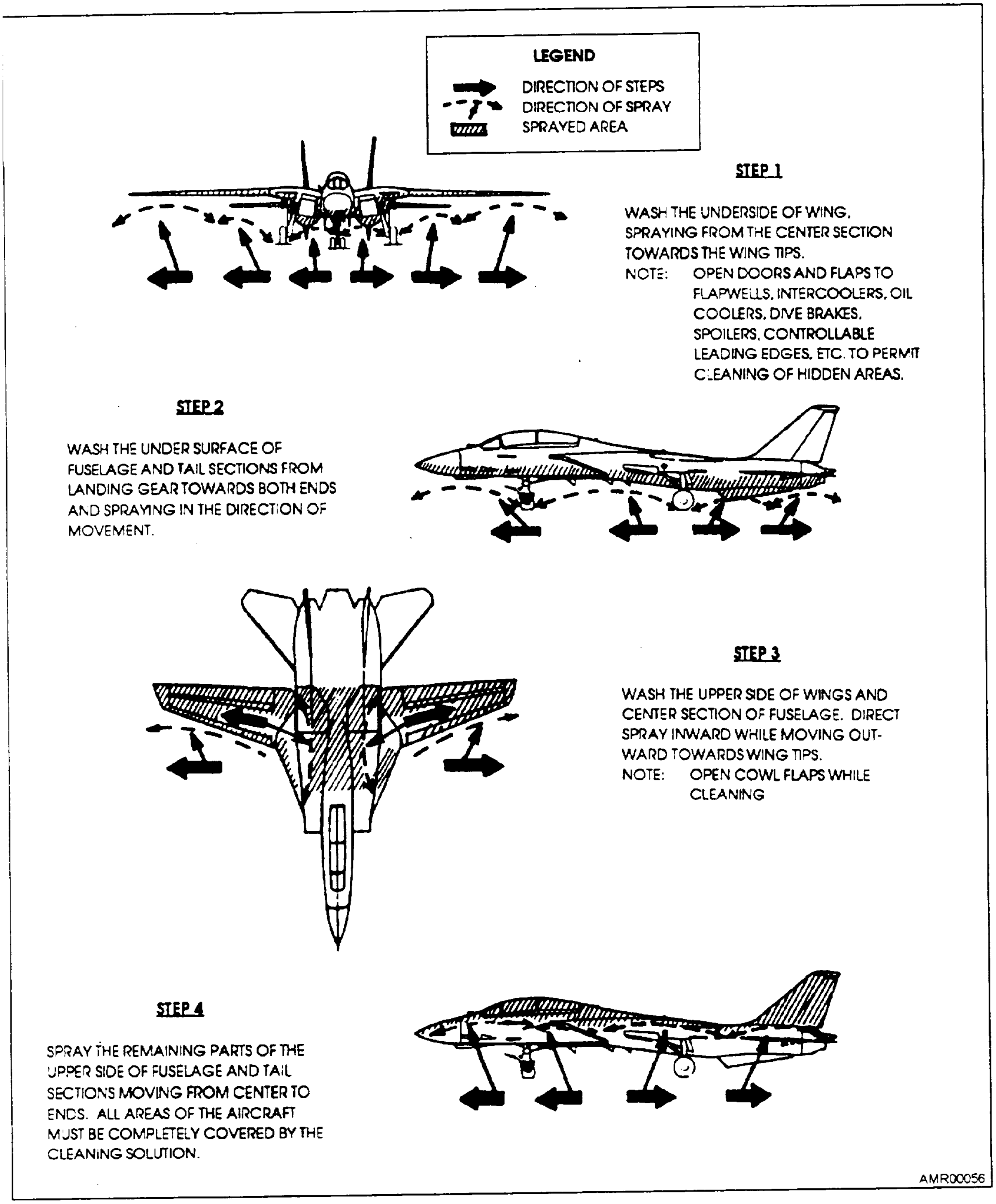


Figure 4-6.—Aircraft washing procedures.

Detergent Cleaning With Limited Water

Use this method only when water is limited.

- Prepare the aircraft for cleaning. Then mix the proper amounts of aircraft cleaning compound and water in a bucket.

- Apply the cleaner with a scrub brush, sponge, rag, or cleaning and polishing pad. Apply to one small area at a time.

- Scrub the area. Then remove the cleaner and loosened soils with a cloth.

- For soils that are resistant to the limited water procedure, clean with dry cleaning solvent (P-D-680, Type II or III) then repeat with the cleaning compound and water mixture.

- Apply water displacing, ultrathin, film corrosion preventive compound MIL-C-81309, type II, and wipe with a clean, dry cloth.

Waterless Wipedown Cleaning

Use waterless wipedown procedures only when water is not available for rinsing or when cold weather prevents the use of water. Using a plastic spray bottle, apply MIL-C-85570, Type I or II (mixed IAW NAVAIR 01-1A-509). Alternatively, spray the cleaner from an aerosol can and wipe off contaminates from the surface.

Spot Cleaning

Spot clean light, oily, soiled surfaces by wiping with dry-cleaning solvent. Apply the solvent by using a saturated wiping cloth. Brush or wipe the surface as necessary; then wipe clean with a dry cloth. The solvent wipe may leave a light residue. Remove this residue with soap and water, followed by a fresh water rinse.

NOTE: After cleaning an aircraft, relubricate it as specified by the MRCs. Ensure that all low-point drains are open, covers and shrouds are removed, and that aircraft preservatives are applied to clean, exposed, unpainted surfaces. Also make sure that the felt wiper washers on all hydraulic cylinders are moistened, and wipe down actuating cylinder rods with a clean rag saturated with hydraulic fluid. Remove and replace damaged or loosened sealant as specified by the applicable MIM.

Q27. Why is the conformable applicator cleaning pad better than a mop or bristle brush when cleaning aircraft surfaces?

Q28. Types I, II, and IV of what cleaning compound are to be used on tactical paint schemes?

Q29. What is the first step in efficiently cleaning an aircraft?

Q30. When cleaning an aircraft what are the two directions in which cleaning compound and rinsing are applied?

Q31. What substance may be used to spot-clean lightly soiled areas?

AVIONICS EQUIPMENT CLEANING

Dust and contamination cause corrosion problems in avionics equipment. Cleaning prevents many of these problems. Therefore, cleaning is the first logical step after an inspection. Cleanliness is very important in maintaining the functional integrity and reliability of avionic systems. Dirt may be either conductive or insulating. As a conductor, it may provide an undesired electrical path. As an insulator, it may interfere with proper operation. Dust, fingerprints, surface oxides, contaminants, or other foreign material on a surface can undo all the good provided by protective coatings.

A good maintenance practice is to use the mildest cleaning method that will properly decontaminate the equipment. It is also important to use the correct cleaning solutions and cleaning materials to avoid damage to avionics equipment. Some of the hazards associated with the cleaning of electronic and electrical equipment are as follows:

- Cleaning solvents or materials can be trapped in crevices or seams. This interferes with later applications of preservative coatings and causes corrosion as well.

- Vigorous or prolonged scrubbing of laminated circuit boards can damage the boards.

- Certain cleaning solvents soften conformal coatings, wire coverings, acrylic panels, and some circuit components.

WARNING

Dry-cleaning solvent should not be used in oxygen areas or around oxygen equipment. Dry-cleaning solvent is NOT oxygen compatible and will cause explosion and/or fire.

When dust. contaminants, or corrosion are detected, action is required. If the corrosion is within repairable limits specified in the applicable MIM or local directive. initiate corrective action. Corrective action includes cleaning, corrosion removal, treatment. and preservation.

The nature of some surfaces, such as chrome-, nickel-, gold-, and silver-plated contacts. limits the use of highly abrasive cleaning methods. You can remove tarnish and light corrosion from these surfaces by rubbing with one of the following materials:

- An eraser (conforming to specification ZZ-E-661) known as magic rub, ruby red, wood, or paper encased (pencil-type) or typewriter eraser
- A nonabrasive cleaning pad (MIL-C-83957) for laminated circuit boards. waveguides, relay contacts. etc.
- A brush (toothbrush H-T-560 or typewriter brush H-B-681) for general scrubbing of dirt, soil, and corrosive products on circuit components

Remove light to heavy corrosion from surfaces, such as covers, connectors, receptacles, antenna mounts, equipment racks, and chassis, by hand rubbing and by using aluminum oxide abrasive cloth. You may use either MIL-A-9962, type I, grade A (very fine), grade B (fine), or aluminum oxide abrasive cloth P-C-451, 320 grit, to do this task.

USE OF COVERS AND SHROUDS

When an aircraft is delivered by the manufacturer, it has a complete set of tailored dust and protective covers. Figure 4-7 shows a typical set of covers.

Install all covers so free drainage will occur. Do NOT create a bathtub that will trap-and hold water. In warm weather, shrouds and covers cause a greenhouse effect, and cause condensation of moisture. Therefore, loosen and remove shrouds and covers and ventilate the aircraft on warm sunny days. However, where protection from salt spray is required, leave the covers in place, and ventilate the aircraft in good weather

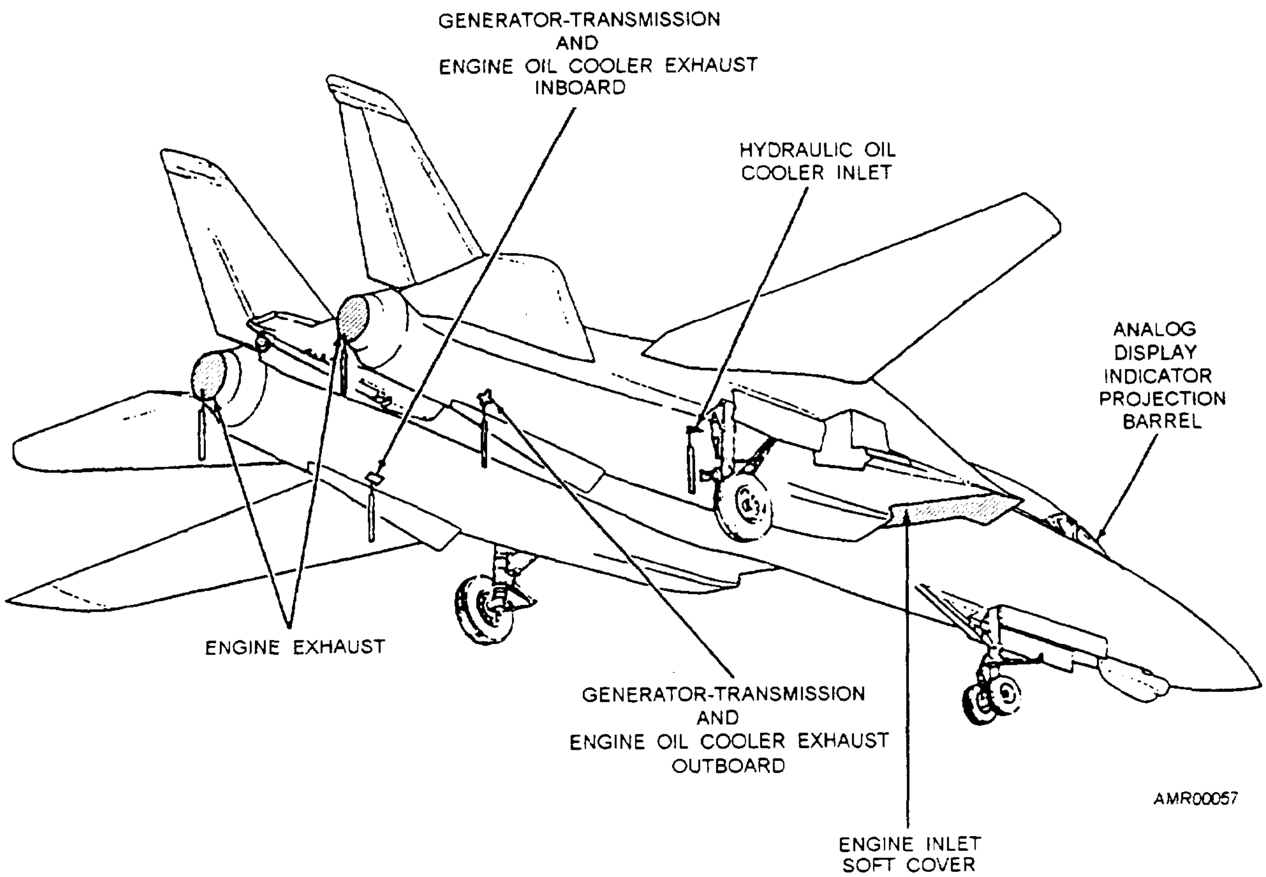


Figure 4-7.—Dust and protective covers.

only. Fresh water condensation does far less damage than entrapped salt spray.

In emergencies where regular waterproof canvas covers are not available, use a polyethylene sheet, polyethylene-coated cloth, or metal foil barrier materials as covers and shrouds. Hold these covers in place with adhesive tape that is designed specifically for severe outdoor applications.

GROUND HANDLING REQUIREMENTS

The MIM for an aircraft usually describe brief and simple ground-handling procedures. When followed, these procedures reduce corrosive attack. These procedures keep water, salt, and dirt out of areas that are difficult to get at and easy to overlook. As you can see, they also save a tremendous amount of maintenance work later.

Many practices, when followed, lessen paint damage and the loss of built-in protective systems during normal ground handling of the aircraft. Some of these practices are listed below.

- Use the tie-down points provided. Much damage is done to aircraft paint films by failure to use the tie-down points or by passing tie-down cables and lines over or around supporting structures so the paint finish is worn, chipped, or broken.

- Take time to wipe or brush sand or gravel from shoe soles before climbing on the aircraft. Painted aircraft surfaces will withstand a normal amount of foot traffic and abrasion by fuel hoses and air lines. However, shoe soles and fuel hoses pick up bits of sand, gravel, and metal chips. These become a coarse abrasive that scratches and scuffs the protective finish so it is completely ineffective under shipboard operating conditions.

- Do not place removed hardware on the deck. When you remove cowling and access plates during inspections and you cannot provide pads or cushions for them, secure them to prevent their movement.

- Avoid scratching the paint when you use hand tools to remove screws and quick-opening fasteners on aircraft exteriors. As little as 5 minutes of extra time spent carefully using tools might save hours of paint touch-up and corrosion removal.

Q32. *Why should dry-cleaning* solvent *not be used in oxygen areas or around oxygen equipment?*

Q33. *In emergencies when regular waterproof canvas covers are not available, what materials can you use as covers and shrouds?*

Q34. *The ground handling requirements for an aircraft can be found in what publication?*

RECOVERY AND RECLAMATION OF CRASH DAMAGED AIRCRAFT

LEARNING OBJECTIVE: Identify publications used to describe emergency reclamation procedures.

General procedures are required anytime an aircraft is exposed to gross amounts of saltwater or fire-extinguishing agents. Each activity that is assigned custody of aircraft has a recovery and reclamation team. The size and composition of the team depend upon the urgency of the situation. As a maintenance crew member, you may be called upon to assist with reclamation of an aircraft. Recovery and reclamation procedures are covered in detail in NAVAIR 01-1A-509.

Methods for cleaning support equipment (SE) are different from those used to clean aircraft. Authorized SE cleaning materials and procedures are identified in *Ground Support Equipment Cleaning and Corrosion Control,* NAVAIR 17-1-125.

Q35. *What technical publication covers emergency reclamation procedures for naval aircraft?*

LEVELS OF AIRCRAFT PRESERVATION

LEARNING OBJECTIVES: Describe the levels of aircraft and engine preservation. Identify the preservatives and sealants used in the preservation of aircraft and support equipment.

The exposure of an aircraft to corrosion damage is greatest when the aircraft is dirty, inactive, or being shipped. Aircraft spend more time on the ground than in the air, even in an active squadron. Therefore, they must be effectively protected. The method of preservation is based on complexity of the aircraft. A variety of methods are used to preserve aircraft. Preservation applies to all types of naval aircraft. There are three different levels of preservation used on naval aircraft:

Level	Use
I	Short-term preservation of flyable and nonflyable aircraft for periods up to 60 days
II	Preservation of aircraft for shipment and for periods of 60 days to 1 year
III	Preservation for long-term aircraft storage for periods of 1 to 8 years

NOTE: Level I preservation will have special MRCs for each aircraft/engine.

As a maintenance crew member, you will be involved with level I preservation. Anytime an aircraft is out of service or will remain idle for 14 or more days, maintenance will put the aircraft in level I preservation. You will use special MRCs to preserve, maintain preservation, and depreserve an aircraft.

Protection against corrosive attack on aircraft is achieved by placing a barrier between the surface and any possible source of moisture. During overhaul or manufacture, protective barriers, such as electroplate, paint, or chemical surface treatment, are provided. Surfaces that cannot be so treated (in some instances, the treated surfaces themselves) are covered with special corrosion-preventive compounds. These compounds are effective only if no moisture, dirt, or active corrosion is present on the treated surface. Therefore, you must thoroughly clean and dry the aircraft before applying a preservative compound. Also, you must apply an unbroken film of preservative in as moisture-free an atmosphere as possible.

Complete protection is not provided by compounds alone. Tapes, barrier paper, and sealing devices are used to seal off the many openings on aircraft. If these openings were to remain open during long-term storage, moisture and dirt would enter and accumulate.

To provide additional protection against corrosion, a complete moisture barrier is sometimes used on aircraft. Unless the cavity is protected by a vapor corrosion inhibitor, use desiccants to dehydrate internal areas that have been sealed. When an area cannot be sealed adequately, provide ventilation and moisture drainage.

When installed equipment in an aircraft is not being regularly used, its components must be preserved. For example, the guns of an aircraft must be cleaned after each firing. The type of oil or other protective treatment used depends upon the anticipated period of idleness for the guns.

In the maintenance of aircraft surfaces under operating conditions, preservation adds to the protection already present. Also, protection coating and barrier materials provide temporary protection to damaged areas. A brief description of some of the more common materials used in aircraft preservation that are readily available in Navy stock is given in the following text.

Corrosion-Preventive Compound, Solvent Cutback

Corrosion-preventive compound, solvent cutback, comes in grades for specific applications. There are five grades of this compound, three of which are commonly used and do not displace water, grades 1, 2, and 4. All grades can be removed with dry-cleaning solvent. These materials are designed for cold application.

Grade 1 preservative forms a dark, hard-film, opaque cover. Its general use is limited because of the difficulty in removing aged coatings. Also, it hides what corrosion is present when it is applied over corroded areas. This material is used where maximum protection against salt spray is required. The military specification is MIL-C-16173, grade 1.

Grade 2 is a thick soft, greaselike compound which is used primarily to protect metal surfaces against corrosion during rework or storage periods. The military specification is MIL-C-16173, grade 2.

Grade 4 preservative forms a thin, semitransparent film through which identification dates can be read. It sets up dry enough to the touch, so preserved parts may be handled easily. This grade is effective in protecting wheel well areas and other exposed surfaces where film transparency is required and moderate protective characteristics can be tolerated. Its main disadvantage is that it is easily removed by water spray and requires replacement at l-month intervals under severe exposure conditions. The military specification is MIL-C-16173, grade 4.

Coating Compounds

Activities based outside the Continental United States sometimes receive aircraft via ocean surface shipment. This is especially true of helicopter and limited-range fighter aircraft. These aircraft are protected during shipment with a sprayable, strippable coating system that conforms to MIL-C-6799, type II. Normally, type II coatings are safe on metal, plastic, or painted surfaces. Also, they are useful for protecting clear acrylic surfaces, such as canopies, against abrasion during maintenance or extended periods of downtime.

The type II system consists of a black base coat and a white topcoat that provides heat reflection during outside exposure. Nylon ripcords with finger-size loops are placed about the aircraft before the aircraft is sprayed with this coating. This allows manual stripping of coatings. When properly applied, the coatings can be removed easily. If coatings are sprayed too thin for easy removal, they can be recoated and allowed to dry. The top layer will bond to previous layers, and all layers may be manually stripped in one operation.

Corrosion-Preventive Petroleum (MIL-C-11796)

MIL-C-11796 is designed for hot application. It is available in two classes, class 1 (hard film) and class 3 (soft film). Both classes consist of corrosion inhibitors in petroleum. They are removed with Stoddard solvent or mineral spirits. Where a hard film is not necessary, you should use class 3. Class 3 is easier to apply and remove, yet it gives the same degree of protection as class 1. Class 1 is for long-time, indoor protection of highly finished metal surfaces and aircraft control cables. Class 3 provides protection for metal surfaces, such as antifriction bearings, shock-strut pistons, and other bright metal surfaces. Class 1 must be heated to 170°F to 200°F before it is applied by brush or dip. For brushing, class 3 material must be between 60°F and 120°F, and for dipping, between 150°F and 180°F.

Oil, Preservative, Hydraulic Equipment (MIL-H-46170)

Use hydraulic fluid MIL-H-46170 as a preservative fluid to store hydraulic systems and components. It is also used as a testing medium in stationary test stands within a temperature range of -40°F to +275°F. Hydraulic fluid MIL-H-46170 is NOT to be used in portable test stands that are connected to the aircraft.

This hydraulic fluid is a fire-resistant, synthetic, hydrocarbon, hydraulic fluid similar to MIL-H-83282. MIL-H-46170 is used as a preservative fluid in systems operating on MIL-H-83282.

Lubrication Oil, General-Purpose, Preservative

There are several types of lubricating oils, some of which contain preservatives. Each oil is identified by a specification number. Use the correct oil for each situation. The specification number for the oil described in this section is VV-L-800.

VV-L-800 oil is used to lubricate and protect piano-wire hinges and other critical surfaces. It is also used when a water-displacing, low-temperature, lubricating oil is required. You may apply VV-L-800 as received by brush, spray, or dip. It is readily removed with dry-cleaning solvent or mineral spirits.

Corrosion-Preventive Compound (MIL-C-81309)

MIL-C-81309 corrosion-preventive compound is a water-displacing compound and lubricant that must be reapplied frequently. On exposed surfaces, protection lasts about 7 days at best. On internal areas, protection lasts about 30 days. MIL-C-81309 is available in two types—type II and type III.

Type II is used for external areas. It forms an effective barrier against moisture when used on B-nuts, linkages, bolts, nuts, ejection seat mechanisms, and canopy locks. When you lubricate an area where there are no pressure lubricating fittings (zerk fittings), such as the piano hinges on access doors and control surfaces, spray with type II preservative compound to clean the area before you apply VV-L-800 preservative oil to remove moisture and contaminants.

Type III corrosion-preventive compound is for avionics and electrical equipment usage. It is not for use on exterior areas that will be exposed to the environment. Type III is used primarily on electrical connectors (cannon plugs) and microswitches to remove moisture and contaminants and to prevent corrosion.

Packaging and Barrier Materials

A minimum of packaging is necessary at the operating activity level. However, critical aircraft and engine areas require shrouding against contamination during maintenance and repair. The fuselage must be sealed when cleaning and stripping materials are used on the aircraft. There are several barrier materials available in the Navy stock for sealing and shrouding large aircraft openings. The stock numbers for these materials can be found in NAVAIR 01-1A-509.

Water-vaporproof Barrier Material. This material is a laminated metal foil barrier that has good water-vapor resistance. It is used for closing intake openings, protecting acrylics during cleaning, and for the packaging of removed components and accessories that are returned for overhaul. It is heat sealable with a soldering or clothes iron.

Polyethylene Plastic Film. This barrier material is used for the same purpose as the metal foil barrier material, but it is less expensive. However, it is not puncture resistant. This plastic film is heat sealable only with special equipment.

Polyethylene Coating Cloth. This cloth is used in support equipment covers. Its use is preferred over plastic film material for general shrouding because of its greater tear and puncture resistance.

Tape, Federal Specification PPPT-60, Class 1. This pressure-sensitive tape is used to close small aircraft openings and for direct contact use on noncritical metallic surfaces. It has moderate water-vapor resistance that is adequate for maintenance use.

Pressure-sensitive Adhesive Tape. This tape was developed specifically for exterior preservation and sealing. It can be applied at temperatures as low as 0°F. It should perform satisfactorily over a temperature range of -65°F to +140°F. It is an excellent general-purpose tape for exterior preservation and sealing operations.

Q36. State the levels and terms of preservation used for naval aircraft.

Q37. What level of preservation is required if an aircraft is scheduled to remain idle for more than 14 days but less than 28 days?

Q38. MIL-C-16173, corrosion preventive compound, is available in three grades. Which grade(s) is/are easily removed with dry-cleaning solvent?

Q39. Corrosion-preventive petroleum, class 3, provides protection for what type of surfaces?

Q40. When is general-purpose lubrication oil VV-L-800 used?

Q41. What type of corrosion-preventive compound MIL-C-81309 is used on avionics and electrical equipment?

ENGINE PRESERVATION

NAVAIR 15-01-500, *Preservation of Naval Aircraft,* addresses specific requirements for the cleaning, inspection, protection, maintenance, and depreservation of auxiliary power units, gas turbine engines, and reciprocating engines. This section only highlights some important factors in engine preservation. Refer to the *Preservation Manual* for specific details.

Level I preservation of engines requires the fuel system to remain at least 95% full of fuel for a period not to exceed 60 days. Any fuel system that has been drained of fuel for more than 3 days or is expected to remain inactive for more than 60 days is to be preserved with MIL-L-6081 Grade 1010. and be dehumidified.

Level II and III preservation requirements are also outlined in the *Preservation Manual.* All requirements are listed by type engine and level of preservation desired.

NOTE: In any case of preservation, ensure all logbook entries and preservation tag requirements have been met.

SUPPORT EQUIPMENT PRESERVATION

WARNING

Do NOT use oil-based preservatives around oxygen fittings or oxygen regulators since fire or explosion may result.

The preservation of clean, corrosion-free surfaces is the final step of the preventive maintenance process of SE. The act of preservation helps to protect nonmoving parts by filling air spaces, displacing water, and providing a barrier to corrosion.

Preservatives For SE

Preservatives are used after SE cleaning before ocean assignment when an extended period of SE storage is anticipated. Preservatives are also used wherever paint films require additional preservative (for example, in metal joints, tightly fitting surfaces, and on sump areas). The technical corrosion manual to be used for support equipment is *Ground Support Equipment Cleaning And Corrosion Control,* NAVAIR 17-1-125. This publication takes precedence over any and all MIMs and service instruction manuals (SIMs) at both O- and I-level maintenance activities. This manual spells out specifically which materials and procedures you are to use to clean up corrosion and restore the protective surface. You still follow the maintenance and service manuals in conjunction with matters not pertaining to corrosion control. The four primary preservative compounds recommended for use on SE are listed in table 4-1.

Apply corrosion-preventive compound to all exposed SE hardware items (around light brackets, hand brakes, levers, dissimilar metal joints, and tightly fitting surfaces and so forth). Preserve areas and components according to the following general procedures:

1. After removing corrosion products, clean the surface and spray the area with water-displacing agent, MIL-C-81309, type II.

2. Apply an even, thin coating of corrosion-preventive compound, MIL-C-16173, grade 4, or MIL-C-85054 to all nonmoving, difficult-to-protect areas. Use only MIL-C-16173, grade 4, for fasteners.

3. Dip removable screws and fasteners in corrosion-preventive compound before installation.

4. Remove excess compound from the metal surface with solvent, P-D-680, and clean cloth, DDD-R-30.

Sealants For SE

Sealants are brush- or spatula-applied compounds for SE corrosion prevention. These compounds are used primarily to repair damaged door and cover weather seals, fill depressions resulting from corrosion repair, protect heavy bolts and fasteners, and seal corrosion-prone crevices and lap seals. Two sealants recommended for SE are

- Silicone Sealant MIL-A-46146, type I, and
- Polysulfide Sealant MIL-S-81733 (inhibited) or MIL-S-8802 (uninhibited).

When properly applied, the sealant forms as a barrier to the penetration of moisture. Prepare metal surfaces carefully before the application of a sealant. Do NOT apply sealant over visible moisture. Ensure that the sealant forms a continuous film at all seams, especially where dissimilar metals are in contact. When applying sealants on SE, you should use the following steps:

1. Mix the sealant according to the manufacturer's direction.

2. Dip bolts or fasteners into the sealant so that the threads and shanks are completely covered. Immediately install the bolt in tapped holes.

3. Brush or swab sealant on mating surfaces that form a crevice when assembling parts. Immediately assemble these parts.

4. Pour, spoon, or trowel sealant into crevices that cannot be disassembled for treatment.

Q42. What level of engine preservation requires the fuel system to remain at least 95 percent full of fuel for a period not to exceed 60 days?

Q43. What technical corrosion manual should you use for support equipment?

Q44. What are the two sealants recommended for use on support equipment?

Table 4-1.—SE Preservatives

Preservative compound	Use
Corrosion-Preventive Compound, Water-displacing, Ultrathin Film, MIL-C-81309, type II, class 2	For all exposed metal and hardware not exposed to the elements
Corrosion-Preventive Compound, Water- Displacing, Clear, MIL-C-85054, type I (AMLGUARD)	A general exterior surface preservative to produce an even, thin, nontacky, and clear film
Corrosion-Preventive Compound, Solvent Cutback, Cold Application, MIL-C-16173, grade 4	A general external preservative, which produces a semitransparent film
Corrosion-Preventive Compound, Ultrathin Film, Avionics Grade, MIL-C-81309, type III	A general preservative for internal areas of electric components

CORROSION DETECTION

LEARNING OBJECTIVE: Identify the types, forms, and characteristics of corrosion.

Timely detection of corrosion is essential to any corrosion control program. Of course, corrosion can be detected after a part fails (if the equipment can be recovered). However, then it is too late to do anything about it other than to intensify inspections of other similar aircraft and SE. Inspection for corrosion should be a part of all routine inspections. On every aircraft and piece of SE, there are certain areas that are more corrosion prone than others. You should check these areas carefully. For the corrosion inspection to be thorough, you must know the types of corrosion likely to be found and the symptoms or appearance of each type of corrosion. Sometimes corrosion is hidden, and special detection methods are used to find it. Various aspects of corrosion detection are discussed in the following text.

FORMS OF CORROSION

Corrosion may occur in several forms, depending upon the specific function, size, shape and type of metal involved. Atmospheric conditions and the presence of corrosion-producing agents are also factors in the development of corrosion. The types of corrosion described in this section are the more common forms found on aircraft structures and SE. This text uses the most commonly accepted terms that describe the various types of corrosion.

Uniform (Direct) Surface Attack

The surface effect produced by the direct reaction of a metal surface with oxygen in the air is a uniform etching of the metal. The rusting of iron and steel, the tarnishing of silver, and the general dulling of aluminum surfaces are common examples of surface attack. On aluminum surfaces, if the surface attack is allowed to continue, the surface will become rough and eventually frosted in appearance. Figure 4-8 shows direct surface corrosion on an A-6 landing gear linkage system.

Pitting Corrosion

The most common effect of corrosion on aluminum and magnesium alloys is called "pitting." The primary cause of pitting is the variation in structure or quality between areas on the metal surface in contact with a corrosive environment. Pitting corrosion is first noticeable as a white or gray powdery deposit, similar to dust, which blotches the surface. When the superficial deposit is cleaned away, tiny pits or holes can be seen in the surface. They may appear as shallow indentations or deep cavities of small diameter. Pitting may occur in any metal, but it is particularly characteristic of aluminum and magnesium. Figure 4-9 is an illustration of pitting corrosion.

Crevice Attack or Concentration Cell

Concentration cell corrosion is actually a form of pitting corrosion. Concentration cell corrosion is caused by the difference in concentration of the electrolyte or the active metal at the anode and cathode. When there are concentration differences at two different points in an entrapped pool of water or cleaning solution, anodic and cathodic areas may result. This results in the anodic area being attacked. Figure 4-10 shows the theory of concentration cell corrosion. Areas where there are crevices, scale, surface deposits, and stagnant water traps are prone to this type of attack. Concentration cell corrosion is controlled and prevented by avoiding the creation of crevices during repair work. It is also controlled with sealants and caulking compounds that eliminate voids that trap water.

Intergranular Attack, Including Exfoliation

All metals consist of many tiny building blocks called "crystals" (sometimes called grains). The boundaries between these crystals are commonly called "grain boundaries." Intergranular corrosion is an attack on the grain boundaries of some alloys under specific conditions. During heat treatment, these alloys are heated to a temperature that dissolves the alloying elements. As the metal cools, these elements combine to form compounds. If the cooling rate is slow, they form at the grain boundaries. These compounds differ electrochemically from the material adjacent to the grain boundaries, and they can be either anodic or cathodic to the adjoining areas, depending upon their composition. The presence of an electrolyte results in attack of the anodic area. This attack can be rapid and exist without visible evidence.

As the intergranular corrosion progresses to the more advanced stages, it lifts the surface grain of the

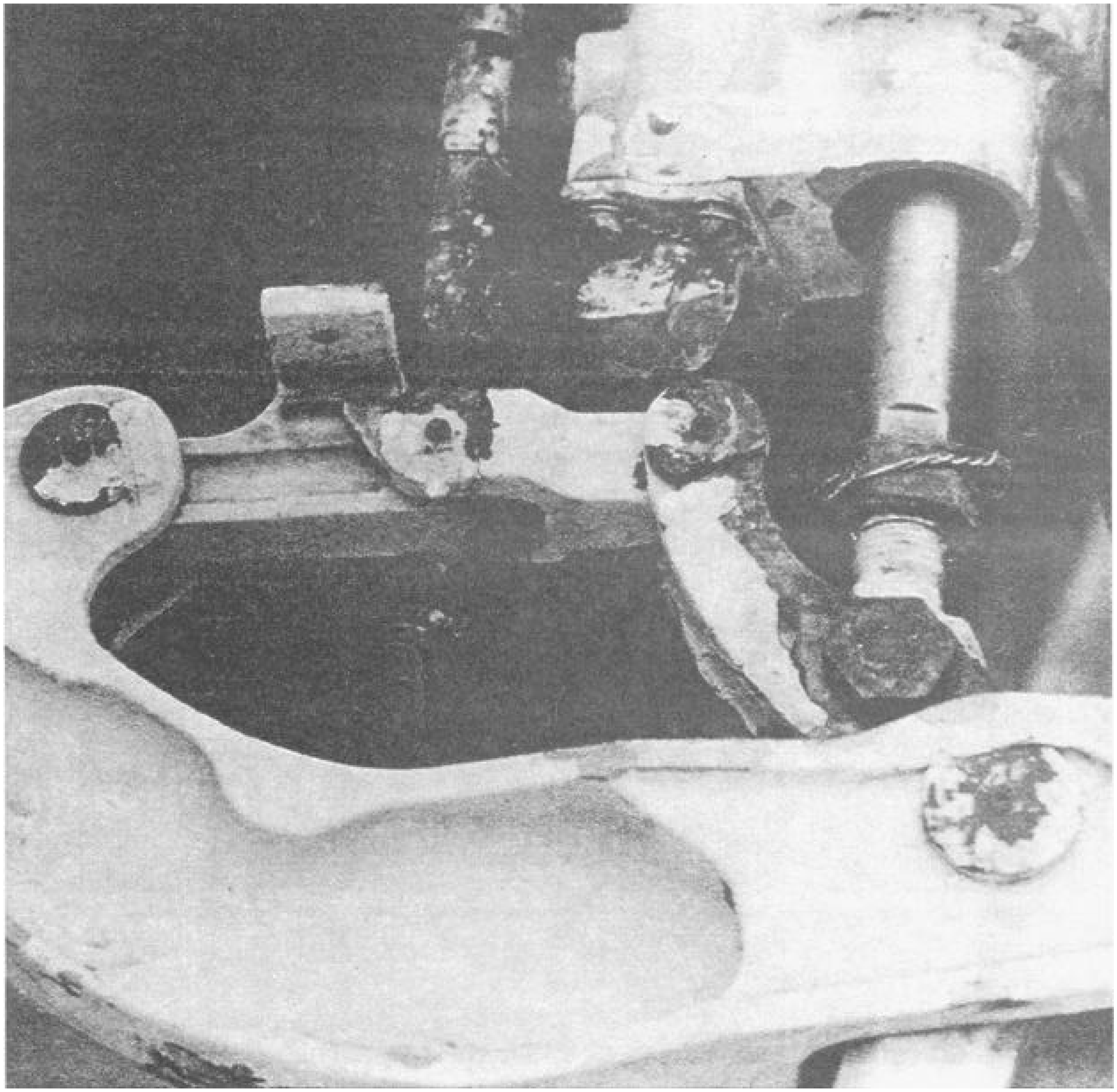


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Figure 4-8.—Surface corrosion on hydraulic linkage.

metal. This is caused by the force of expanding corrosion products at the grain boundaries just below the surface. This advanced attack is called exfoliation (fig. 4-11). At this point, it can be seen by maintenance personnel. Correction of such serious corrosion is vital to aircraft safety. The insidious (sneaky) nature of such an attack can seriously weaken structural members before the volume of corrosion products accumulate on the surface and the damage becomes apparent.

Metal that has been properly heat-treated is not readily prone to intergranular attack. However, localized overheating, such as could occur from welding and fire damage, can make metal prone to attack. If the intergranular attack has not penetrated so far as to impair structural strength, correction as outlined in the applicable structural repair manual (SRM) can restore an aircraft to flight status.

Dissimilar Metal Corrosion

The terms *galvanic* or *dissimilar* metal corrosion are applied when accelerated corrosion of metal is caused by dissimilar metals being in contact in a corrosive medium, such as salt spray or water. Dissimilar metal corrosion is usually the result of a

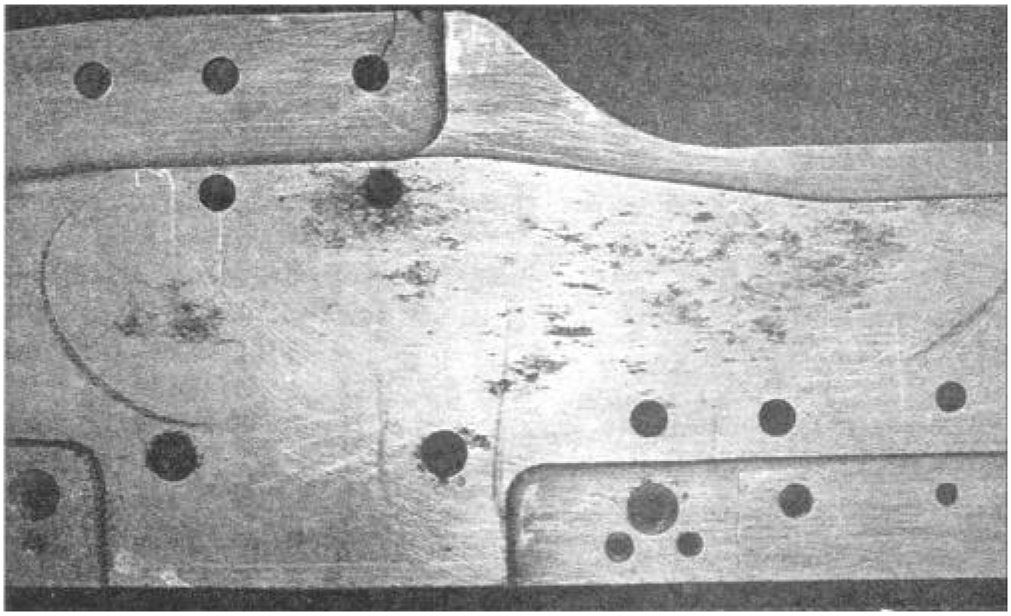

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Figure 4-9.—Pitting of an aluminum wing assembly.

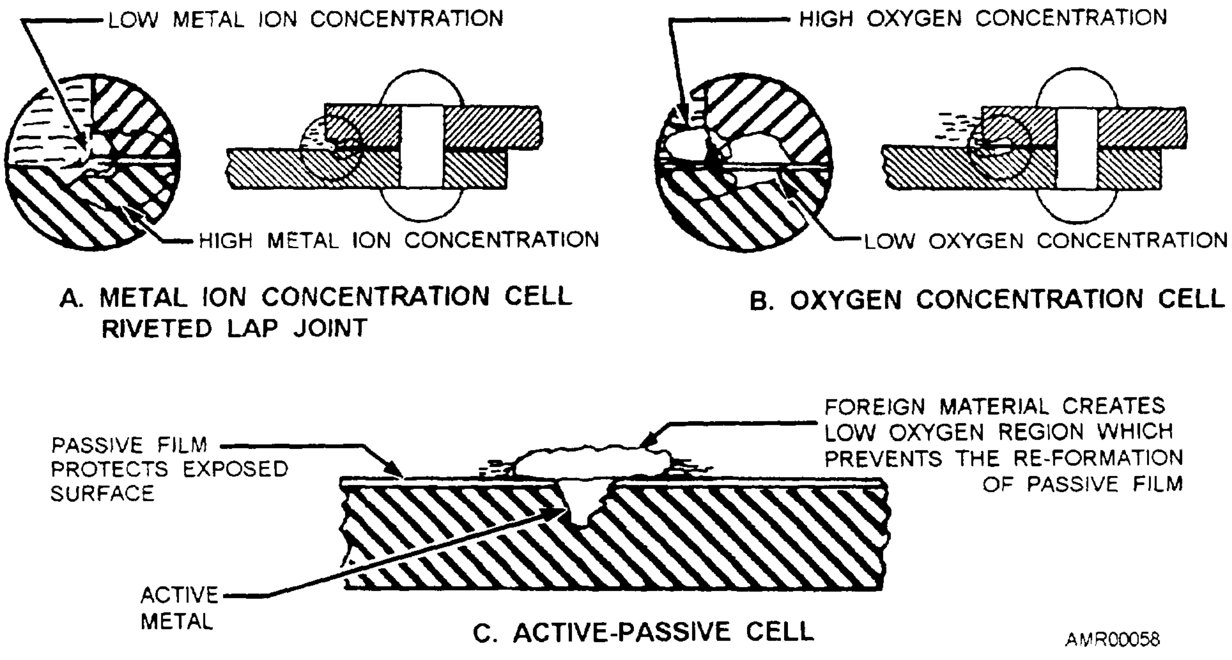

Figure 4-10.—Concentration cell corrosion.

faulty design or improper maintenance practices. You can usually recognize it by the presence of a buildup of corrosion at the joint between the metals. For example, aluminum and steel materials riveted together in an aircraft wing form a galvanic couple if moisture or contamination is present. When aluminum pieces are attached with steel bolts or screws, galvanic corrosion can occur around the fasteners (fig. 4-12).

To keep these metals from coming in direct contact with each other, aircraft and support equipment manufacturers use a variety of separating materials. Such materials include plastic tape, sealant, primer, washers. and lubricants. These materials keep corrosion to a minimum. These separating materials must remain intact and be replaced, restored. or repaired as needed.

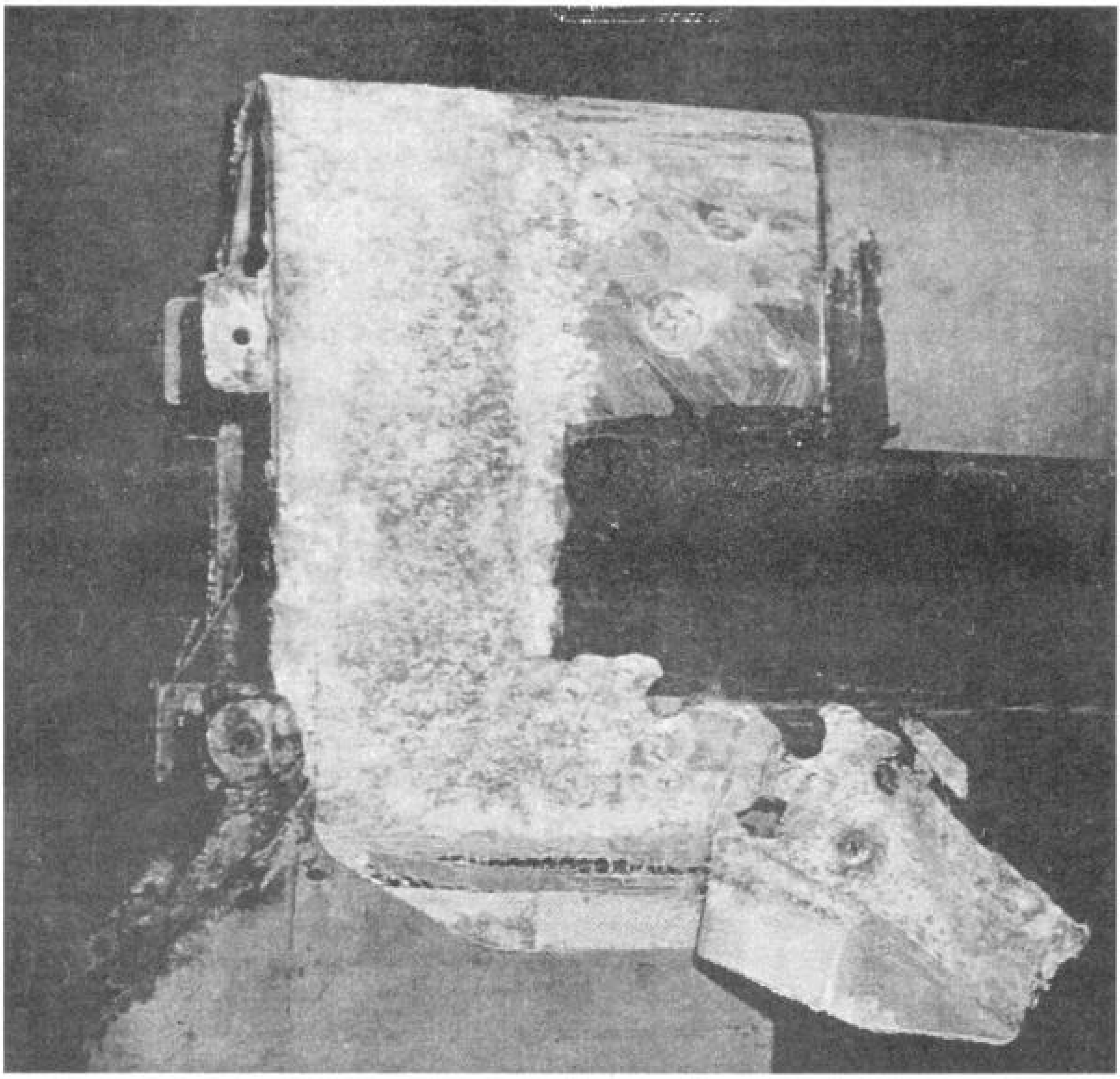

Figure 4-11.—Intergranular corrosion.

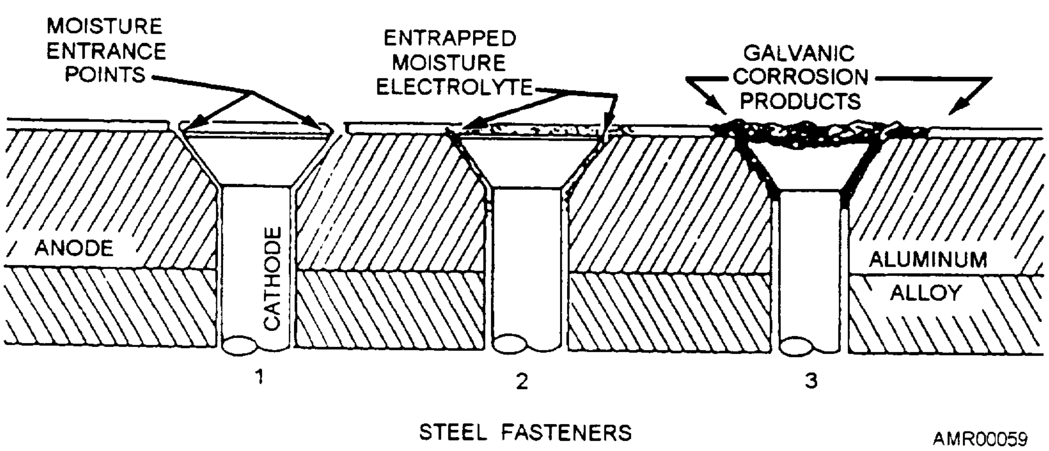

Figure 4-12.—Galvanic corrosion.

Some metals are more active than others. The degree of attack depends upon the relative activity of the two surfaces in contact. The more active or easily oxidized surface becomes the anode and corrodes. In plated metal, the possibility of dissimilar metal corrosion becomes a factor only if there are defects in the plating. Moisture penetrates and galvanic cells form because of these defects.

Stress Corrosion

Stress corrosion is caused by the combined effects of tensile stress and corrosion. Stress may be internal or applied. Internal stresses are produced by nonuniform deformation during cold working, by unequal cooling from high temperatures during heat treatment, and by internal structural rearrangement involving volume changes. Stresses set up when a piece is formed. Stress induced by press-and-shrink fits and those in rivets and bolts are examples of internal stresses. Concealed stress is more important than design stress because it is difficult to recognize before it exceeds the design safety factor. The magnitude of the stress varies from point to point within the metal. Stresses that approach the yield strength of the metal promote stress cracking (visible at this point), but failure can occur at lower stresses (fig. 4-13). Most often, stress cracks are not visible to the naked eye and are discovered in the nondestructive inspection (NDI) process.

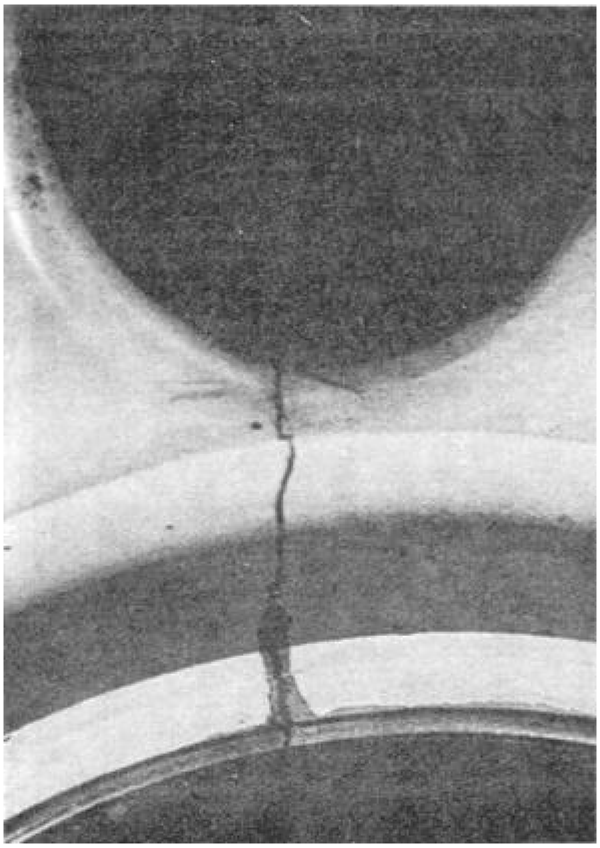

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Figure 4-13.—Stress corrosion cracking.

Fatigue Corrosion

Fatigue corrosion is a special kind of stress corrosion. It is caused by the combined effect of corrosion and stress applied in cycles to a component. An example of cyclic stress is the alternating loads to which the reciprocating rod on the piston of a hydraulic, double-acting, actuating cylinder is subjected. During the extension stroke, a compression load is applied. During the retracting or pulling stroke, a tensile or stretching load is applied. Fracture of a metal part due to fatigue corrosion commonly occurs at a stress far below the fatigue limit in a laboratory environment, even though the amount of corrosion is unbelievably small. This is why protection of parts subject to alternating stress is particularly important in any environment. Figure 4-14 shows an oil cooler blower that disintegrated because of fatigue corrosion of a blade (shown by arrow).

Fretting Corrosion

Fretting corrosion is a limited but highly damaging type of corrosion. It is caused by a slight vibration, friction, or slippage between two contacting surfaces that are under stress and heavily loaded. It is usually associated with machined parts. Examples of these parts are the area of contact of bearing surfaces, two mating surfaces, and bolted or riveted assemblies. At least one of the surfaces must be metal. In fretting corrosion, the slipping movement on the contacting surface destroys the protective films that are present on the metallic surface. This action removes fine particles of the basic metal. The particles oxidize and form abrasive materials, which further agitate within a confined area to produce deep pits. Such pits are usually located in an area that increases the fatigue failure potential of the metal. Early signs of fretting corrosion are surface discoloration and the presence of corrosion products in lubrication. Lubrication and securing the parts so that they are rigid are effective measures to prevent this type of corrosion.

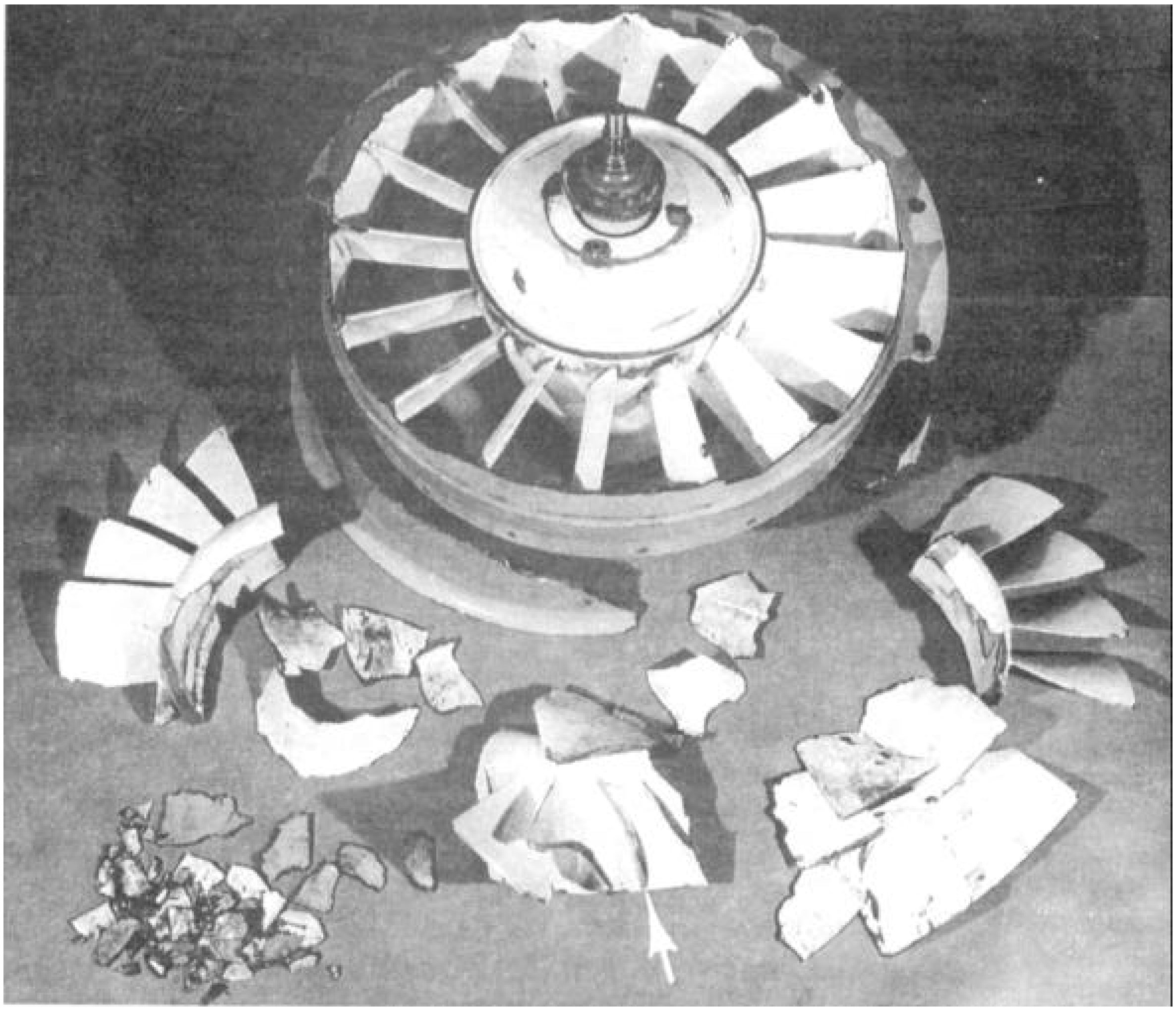

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Figure 4-14.—Oil cooler blower disintegration.

Filiform Corrosion

Filiform corrosion (fig. 4-15) consists of threadlike filaments of corrosion known as underfilm. Metals coated with organic substances, such as paint films, may undergo this type of corrosion.

Filiform corrosion occurs independently of light, metallurgical factors, and microorganisms present. It takes place when the relative humidity of the air is 78 to 90 percent and when the surface is slightly acidic. Although the threadlike filaments are visible only under clear lacquers or varnishes, they also occur under opaque paint film. Filiform corrosion can attack steel, aluminum, and magnesium.

Microbiological Corrosion

Microorganisms contained in seawater can be introduced into fuel systems by contaminated fuel. These fungus growths attack the sealing material used on integral fuel tanks. They can cause corrosion of aluminum, probably by aiding in the formation of concentration cells. Residues from biological growth tend to clog fuel filters and coat fuel quantity probes. Fuel quantity probes thus coated give erroneous readings. Also, moisture aides in the growth of fungi and microorganisms in avionic equipment.

Q45. The tarnishing of silver is a common example of what type of corrosion?

Q46. Pitting is the most common effect of corrosion on what alloys?

Q47. Pitting corrosion is first noticeable as what color deposit on a metal surface?

Q48. How can concentration cell corrosion be controlled or even prevented?

Q49. Define intergranular corrosion.

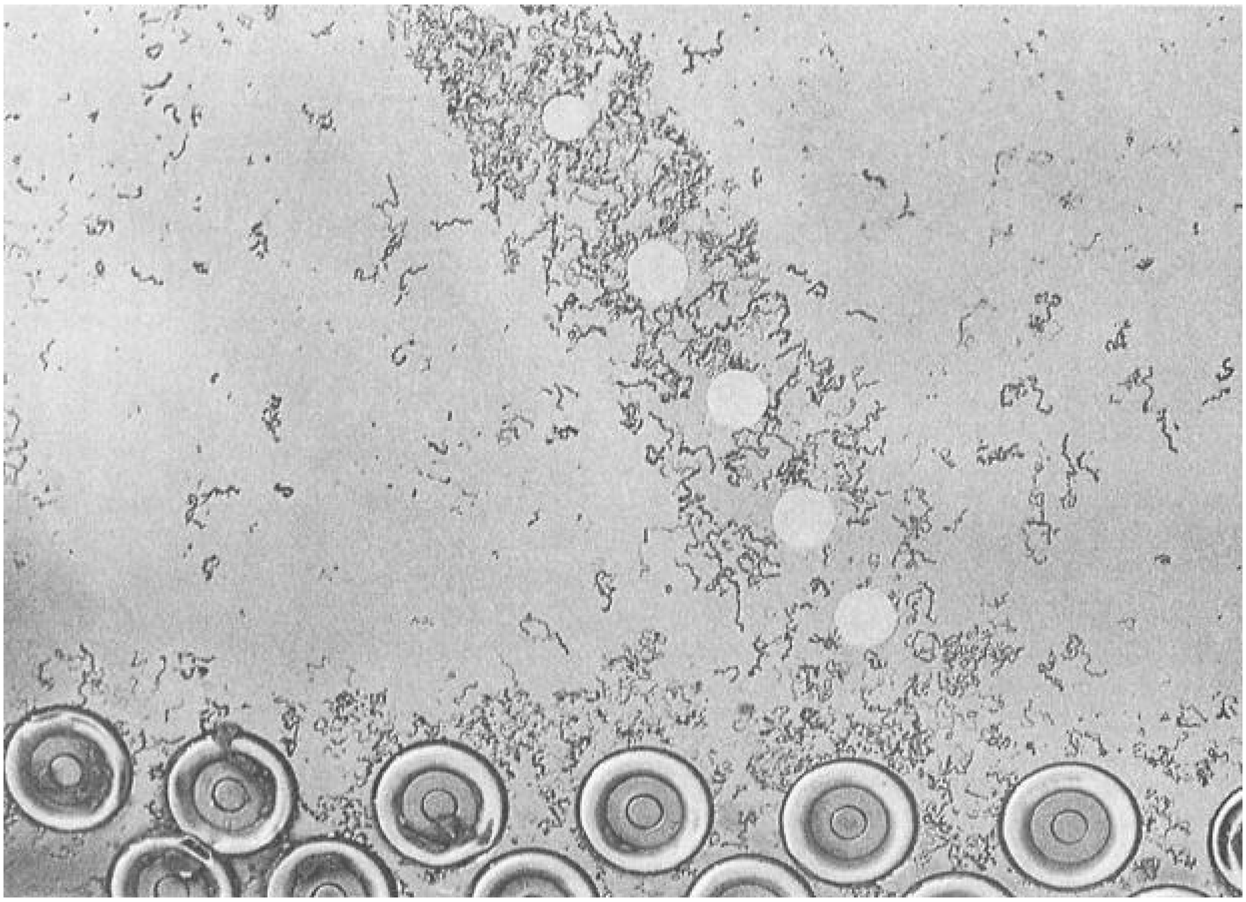

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Figure 4-15.—Filiform corrosion found under paint coating.

Q50. What is usually the cause of dissimilar metal corrosion?

Q51. What are some examples of internal stress corrosion?

Q52. What causes fatigue corrosion?

Q53. What is the cause of fretting corrosion?

Q54. Filiform corrosion occurs on what types of metals?

LOCATION OF CORROSION-PRONE AREAS

LEARNING OBJECTIVE: Describe the areas on an aircraft prone to corrosion.

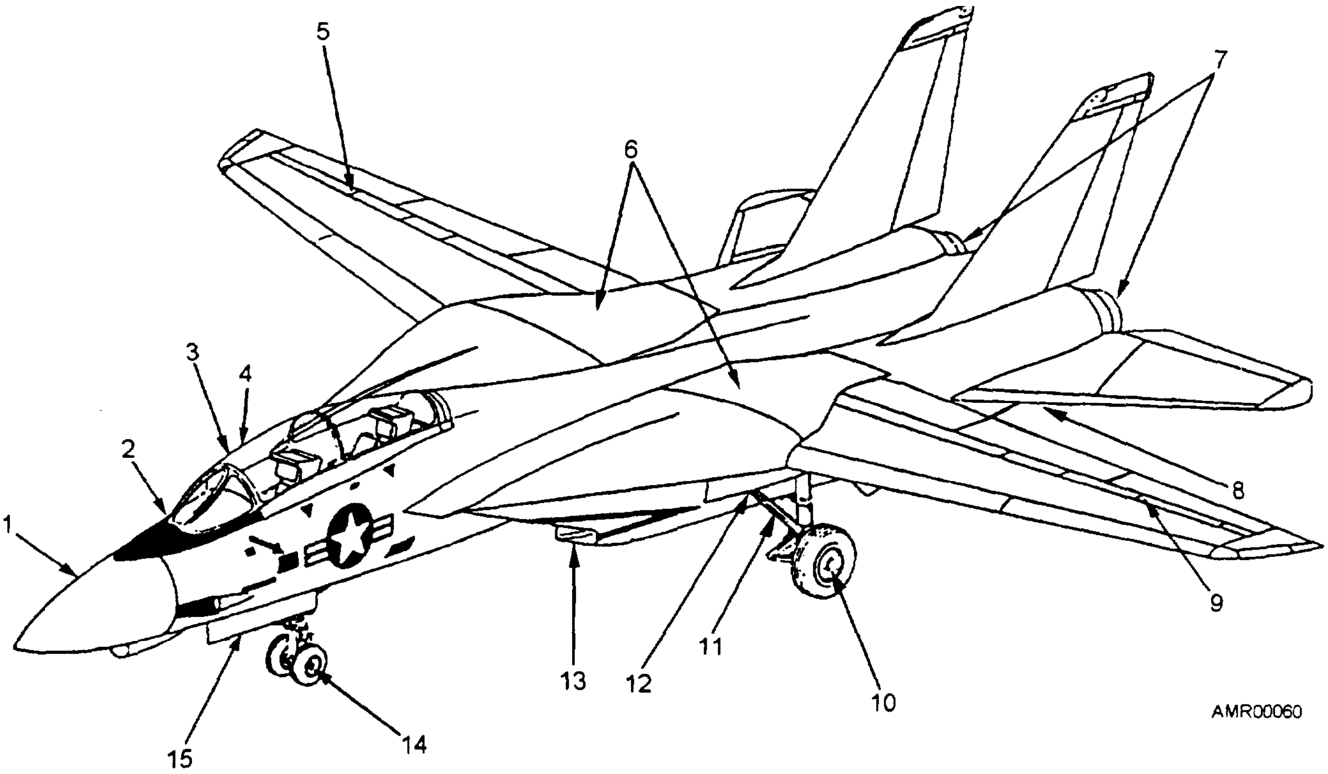
This section discusses corrosion-prone areas common to all aircraft. For specific aircraft, you should refer to the periodic maintenance information cards (PMICs) to locate corrosion-prone areas for that aircraft. Figure 4-16 is an example of possible trouble spots on jet engine aircraft.

Lavatories and galleys are likely trouble spots if they are not kept clean. These areas include the deck behind lavatories, sinks, and ranges where spilled food and waste products may accumulate. Even when contaminants are noncorrosive: they may attract and hold moisture. This, in turn, causes corrosive attack. Maintenance personnel should pay attention to bilge areas located under galleys and lavatories and to personnel relief and waste disposal vents or openings on the aircraft exteriors. Human waste products can corrode common aircraft metals.

Avionic Systems

The control of corrosion in avionic systems is not unlike that in airframes. Procedures useful for airframes apply to avionics, with appropriate modifications. Avionics systems are more prone to corrosion than aircraft because avionics have the following characteristics:

- Less durable protection systems,
- Very small amounts of corrosion can make equipment inoperative.
- Dissimilar metals are often in electrical contact.
- Stray currents are present that can cause corrosion.



1. Radome area
2. Rudder petal
3. Cockpit floor
4. Battery compartment
5. Piano hinges
6. Flight control cables
7. Exhaust areas
8. Missile rocket blast area
9. Flap carriage area
10. Magnesium wheels
11. Exposed rigid tubing
12. Main wheel well
13. Air inlet ducts and engine frontal areas
14. Nose wheel well

Figure 4-16.—Typical corrosion-prone areas on jet engine aircraft.

- Active metals and dissimilar metals in contact are often unprotected.
- Closed boxes can produce condensation during normal temperature changes during flight.
- Avionic systems have many areas to trap moisture.
- Hidden corrosion is difficult to detect in many avionic systems.
- Many materials used in avionic systems are subject to attack by bacteria and fungi.
- Organic materials are often used that, when overheated or improperly or incompletely cured, can produce vapors. These vapors are corrosive to electronic components and damaging to coatings and insulators.

The only requirements for a corrosion cell are a cathode, an anode, and an electrolyte. The size of a cell depends upon the size of its components. A cell can form where a resistor lead is soldered to a terminal, or where two sheets of metal join. It can also form around a rivet head and the adjacent metal. (See figure 4-17, views A and B.) Even two metallic crystals in the same alloy can form a cell. All that is needed is for crystals to be of different composition and in electrical contact with each other in the presence of an electrolyte (fig. 4-17, view C).

Battery Compartments and Battery Vent Openings. Fumes from battery electrolyte are difficult to contain. They will spread throughout the battery compartment, vents, and even adjacent internal cavities. Battery electrolyte fumes cause rapid corrosive attack on unprotected surfaces. Maintenance personnel should check the external skin area around the vent openings regularly for this type of corrosion. Corrosion from this source is a serious problem

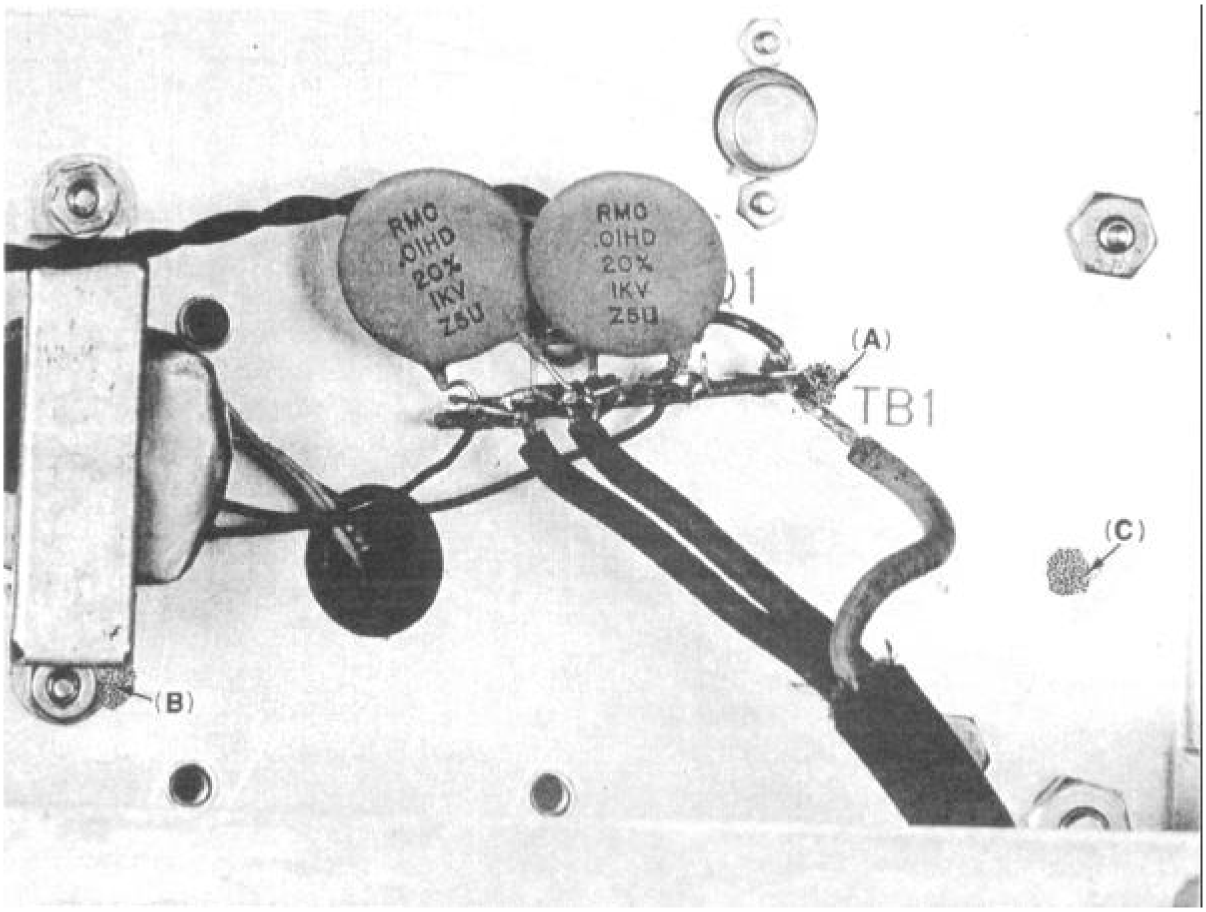


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Figure 4-17.—Electrochemical corrosion.

whenever batteries are used. The battery compartment shown in figure 4-18 needs immediate attention.

> **WARNING**
>
> Before performing any cleaning, inspection, or maintenance on electrical systems, maintenance personnel should make sure that all electrical power is secured from the aircraft. If the electrical power is NOT secured from the aircraft, it could result in serious injury to maintenance personnel.

Multiple Electrical Connectors (Cannon Plugs). Connectors mounted in avionic and electrical systems are prone to the same corrosive environment as airframe structural components (fig. 4-19). Normally, connectors and mounting plates contain a gasket that acts as a watertight seal. When maintenance personnel dismantle (take apart) a connector for cleaning or repair, they should inspect the gasket. They should give special attention to connectors that use replaceable pins. These connectors use a self-sealing gasket water seal or dog bones (plastic inserts) that automatically seal the connectors against water intrusion. The repeated removal and replacement of the pins or forgetting the dog bones may cause the watertight seal to lose its effectiveness. In extreme cases where the connector cannot be replaced, potting compounds must be used to prevent water intrusion. You can find the stock numbers for dog bones in the applicable IPB.

Coaxial Connectors. Look at figure 4-20. It shows corrosion on a coaxial connector. Coaxial connectors require special steps to avoid water intrusion. Usually, moisture, contaminants, and corrosion in fuel quantity, oil quantity, and similar capacitive-type indicating system connectors cause erroneous (wrong) quantity indications in the cockpit indicating systems. Antenna coaxial connectors have similar problems with moisture.

Wire Harnesses and Cables. When corrosion is discovered at the pin-to-wire connection on electrical connectors, plugs, and receptacles, the wire harness

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Figure 4-18.—Battery compartment.

and cables should be inspected for corrosion attack and cracking of the wire insulation. Cable shielding is particularly prone to corrosion.

Ram Air Turbine (Rat) Compartments. Maintenance personnel should inspect RAT compartments for moisture traps. They should inspect all mounting hardware, electrical connectors, terminal boards, junction boxes, and the RAT itself for signs of corrosion that may have been caused by moisture spray.

Electrical Bonding and Grounding Straps. The bonding and grounding straps used on aircraft and electrical equipment are major sources of galvanic corrosion. Usually, this strap is made of a metal that is dissimilar to the areas to which it is attached. Thus, a galvanic couple is created. Unless maintenance personnel take proper preservation action, this couple, in the presence of moisture, corrodes at a rapid rate.

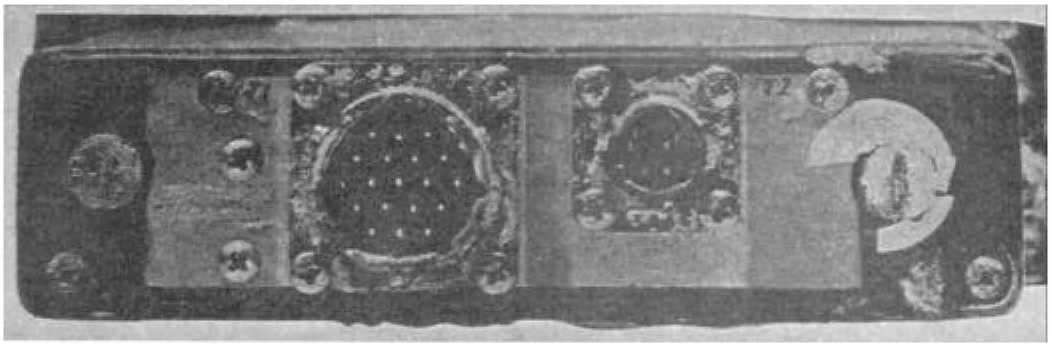

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Figure 4-19.—Corrosion on control box electrical connectors.

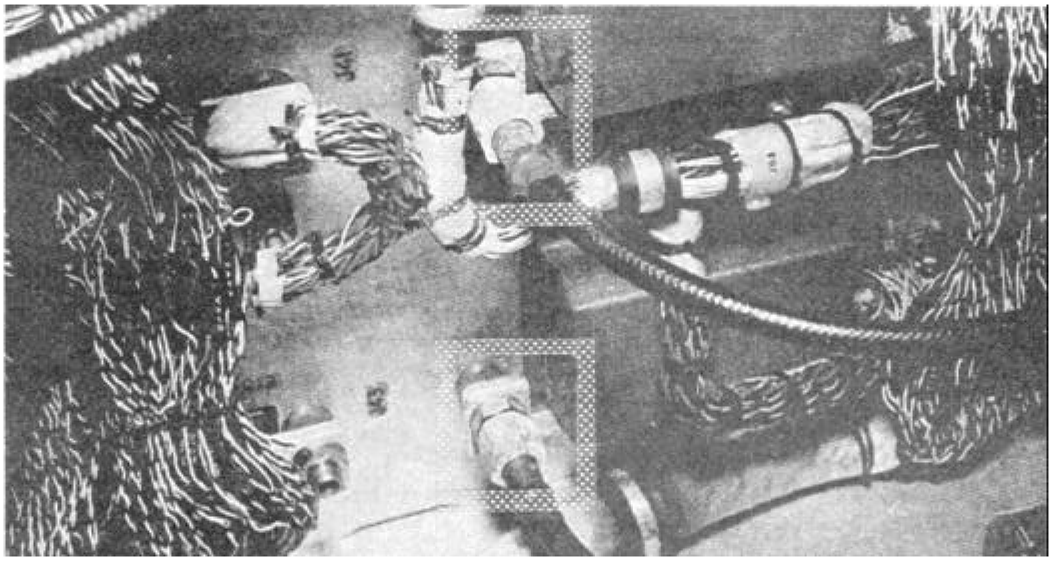

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Figure 4-20.—Corrosion on coaxial connector.

Light Assemblies. External formation lights, wing tip lights, rotating beacons, and lower fuselage anticollision lights are highly prone to corrosion. These lights are prone to corrosion because of poor seals, exposure to the elements in flight, or water intrusion during aircraft washdown. Usually, corrosion is heavy at the bases of the bulbs because of dissimilar metal contact between bulbs and sockets. Seals and preservation actions reduce the likelihood of corrosion in light assemblies.

Q55. The corrosion-prone areas for each specific aircraft are derailed in what publication?

Q56. What are the three requirements for a corrosion cell to form?

Ejection Seats

Aboard ship, salt spray enters most aircraft cockpit areas when the canopies are opened for respotting of aircraft maintenance or to accommodate the manning of ready alert aircraft. While the cockpit and ejection seats are not as corrosion prone as some other areas, they are still in a corrosive environment. Therefore, the cockpit and ejection seats require constant attention, along with other parts of the aircraft.

Because of their construction and location, ejection seats are difficult to inspect and clean thoroughly while they are installed in the aircraft. Also, there is a lengthy period of time between aircraft inspections that require seat removal. Therefore,

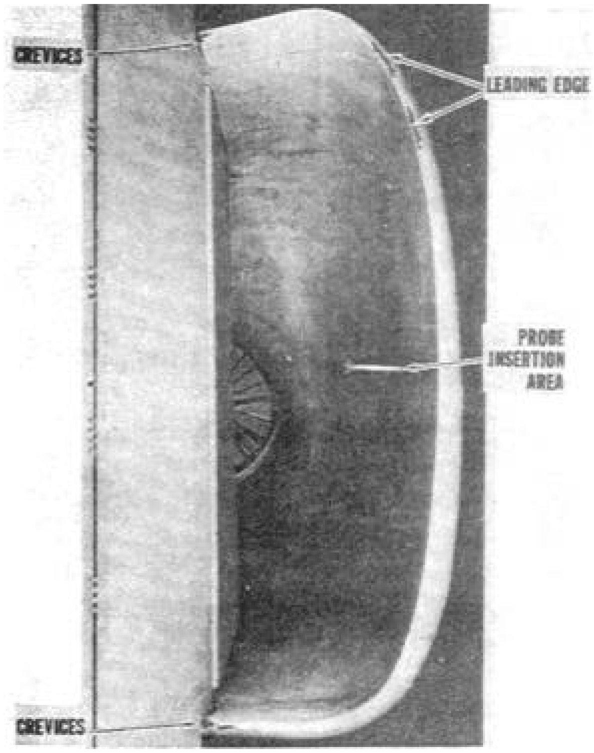

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Figure 4-21.—Corrosion-prone point of air inlet duct.

ejection seats could become severely corroded if not given adequate attention.

The likelihood that slight corrosion could make an ejection seat inoperable must not be overlooked. The MRCs for these seats require that every portion of the seats be checked thoroughly for corrosion when they are removed from the aircraft. Additional emphasis is usually given to the ultrahigh-strength steel parts of seats. As with all aircraft parts, corrosion could weaken the structural soundness of a seat. Maintenance personnel should give worn paint finishes and those showing signs of superficial corrosion immediate attention, as specified in the applicable MIM, because other problems not yet visible may be present. They should touch up cockpit fasteners with dull, black paint to prevent cockpit glare. Refer to NAVAIR 01-1 A-509 for more information.

Intake and Exhaust Trail Areas

Airborne dirt and dust and bits of gravel from runways constantly erode engine frontal areas and cooling air vents. Rain erosion removes the protective finish on intake and exhaust areas (fig. 4-21). In addition, areas such as air intake ducts and cooler radiator cores are not painted. Engine accessory mounting bases usually have small areas of unpainted magnesium or aluminum on the machined mounting surfaces. With moist, salt-laden air constantly flowing over these surfaces, they are prime sources of a corrosive attack (fig. 4-22). When maintenance

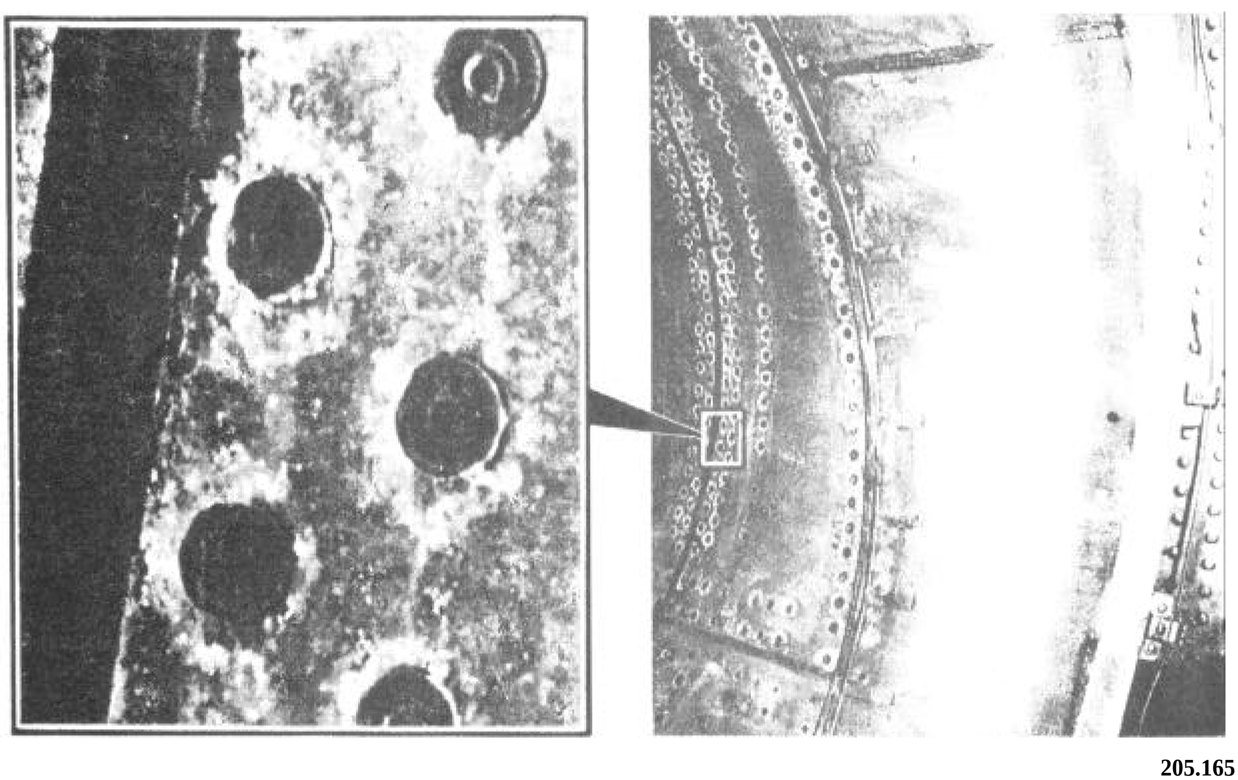

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Figure 4-22.—Corrosion in air intake duct.

personnel inspect such areas, they should also inspect all sections in the cooling air path, giving special attention to obstructions and crevices where salt deposits may build up during marine operations. Corrosion must be checked in its early stages and paint touch-up and hard-film, preservative coatings must be maintained intact.

Jet exhaust deposits are very corrosive. These deposits are particularly troublesome where gaps. seams, hinges, and fairings are located down the exhaust path, and where the deposits may be trapped and not reached by normal cleaning methods. When inspecting these surfaces, maintenance personnel should give special attention to the areas indicated in figure 4-23. Maintenance personnel should also include in their inspection procedures the removal of fairings and access panels located in the exhaust path.

JATO, Rocket, and Gun Blast Areas

Surfaces located in the path of JATO, rocket, and gun blasts are particularly subject to corrosive attack and decay (fig. 4-24). In addition to the corrosive effect of the gases and exhaust deposits, protective finishes are often blistered by heat and blasted away by high-velocity gases. Also, spent shell casings or solid particles from gun and rocket exhausts abrade finishes. Maintenance personnel should watch these areas for corrosion and clean the finishes carefully after firing operations.

Bilge Areas

Bilge areas are common trouble spots on all aircraft. One example of a bilge area is the engine bay area. Bilge areas are natural collection points for waste. hydraulic fluids, water, dirt, loose fasteners, drill shavings, and other debris. Oil puddles often mask small quantities of water, which settle to the bottom and set up hidden corrosion cells. Keeping bilge areas free of extraneous material, including oil, is the best insurance against corrosion.

Wheel Wells and Landing Gear

The wheel well area probably receives more punishment than any other area on the aircraft. It is exposed to mud, water, salt, gravel, and other flying debris from runways during flight operations. It is open to salt water and salt spray when the aircraft is parked aboard ship. Because of the many complicated shapes, assemblies, and fittings in the area, complete coverage with a protectile paint film is difficult to attain. Because of the heat generated from braking,

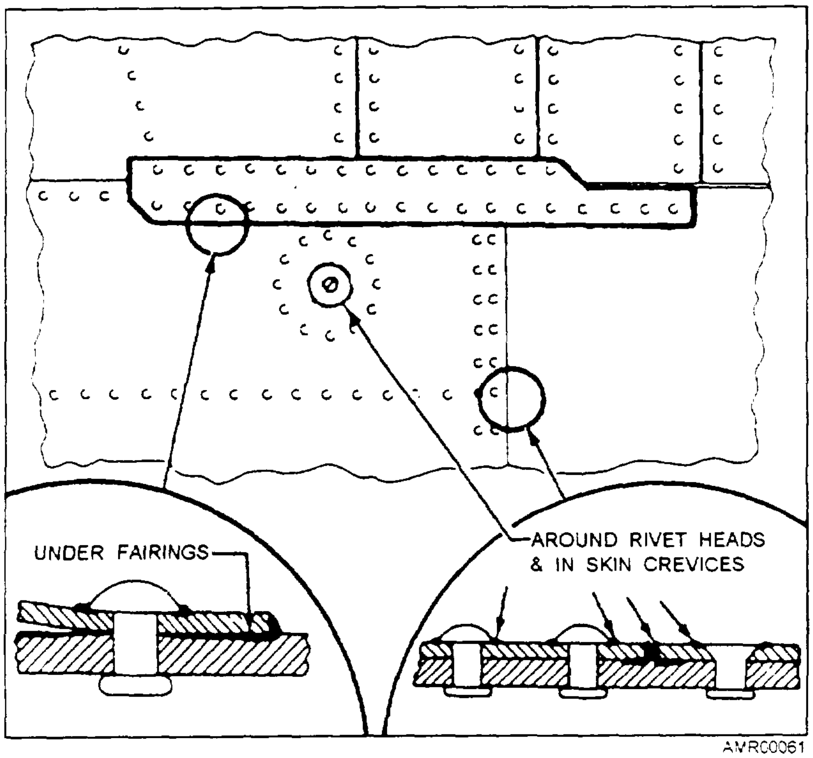


Figure 4-23.—Exhaust trail corrosion points.

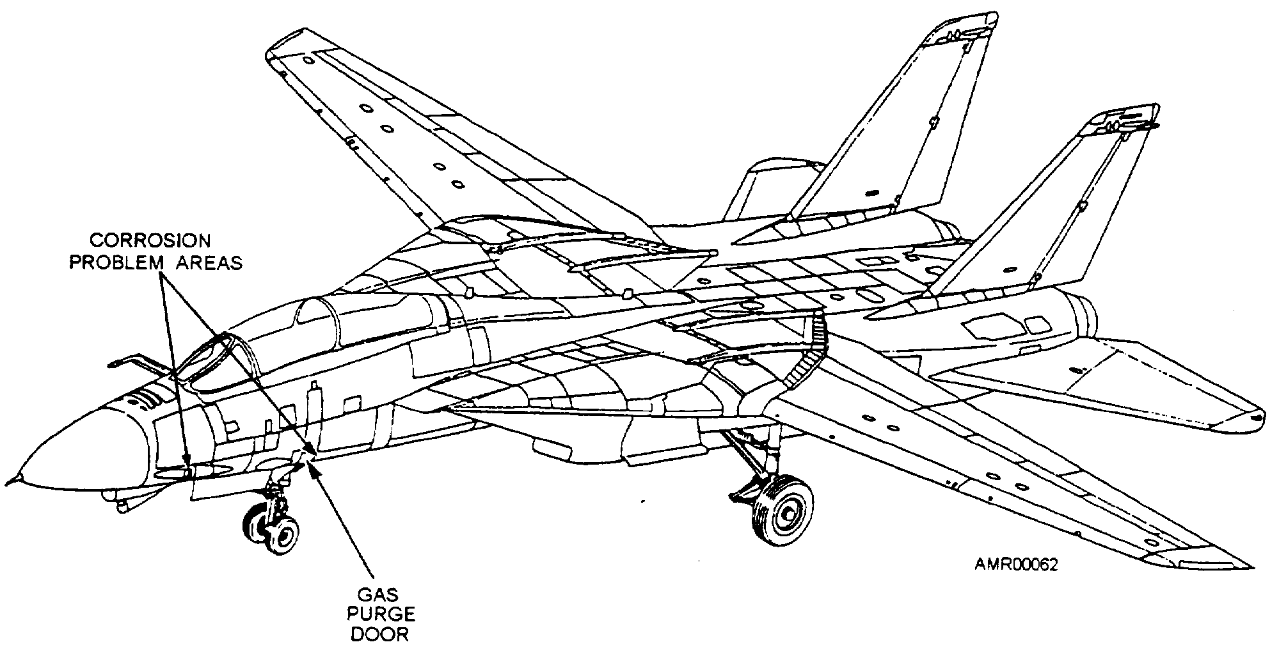


Figure 4-24.—Gun blast area corrosion points.

preservative coatings are not used on jet aircraft landing gear wheels. During inspections, maintenance personnel should pay particular attention to the following areas:

- Magnesium wheels, especially around bolt heads, lugs, and wheel well areas
- Exposed metal tubing, especially at nuts and ferrules, and under clamps and identification tapes
- Exposed connectors, such as indicator switches and other electrical equipment
- Crevices between stiffeners, ribs, and lower skin surfaces, which are typical water and debris traps

Water Entrapment Areas

Aircraft have drains installed in areas where water may collect. However, these drains may not be effective either because of improper location or because they are plugged by sealants, fasteners, dirt, grease, and debris. Daily inspection of drains is a standard requirement, especially aboard ship.

Q57. Cockpit fasteners should be touched up with what color paint?

Q58. In water entrapment areas of an aircraft, drains are required to be inspected how often?

Wing Fold, Flap, and Speed Brake Recesses

Flap and speed brake recesses are potential corrosion problem areas because they are normally closed when on the ground. Dirt and water may collect and go unnoticed. Wing fold areas contain complicated shapes and assemblies that are difficult to cover with a protective paint coating or preservative film; thus, corrosion is present. Wing fold areas are extra vulnerable to salt spray when wings are folded aboard ship. To thoroughly inspect this area, maintenance personnel should use a mirror to check the back sides of tubing and fittings. Also, they should pay particular attention to aluminum alloy, wing lock fittings (such as those used in some current aircraft models).

External Skin Areas

Most external aircraft surfaces are ordinarily covered with protective paint coatings and are readily visible or available for inspection and maintenance. Even here, certain types of configurations or combinations of materials can cause trouble under shipboard operating conditions and require special attention.

Magnesium skin, when painted over, is not visibly different from any other painted metal surface. Magnesium surfaces are identified in the applicable structural repair manual. When an aircraft contains magnesium skin panels, maintenance personnel must give special attention to these panels during inspections for corrosion. Some aircraft have steel fasteners installed through magnesium skin with only protective finishes under the fastener heads or tapes over the surface for insulation. In addition, paint coatings are thin at trimmed edges and comers. These conditions, coupled with magnesium's sensitivity to saltwater attack, present a potential corrosion problem whenever magnesium is used. Therefore, maintenance personnel must inspect all magnesium skin surfaces for corrosion, giving special attention to edges, areas around fasteners, and cracked, chipped, or missing paint.

The entrance and entrapment of corrosive agents between the layers of metal cause corrosion of spot-welded skins. (See figure 4-25.) Some of the corrosion may be caused originally by fabrication processes, but its progress to the point of skin bulging and spot-weld fracture is the direct result of moisture or salt water working its way in through open gaps and seams. The first indication of this type of corrosion is the appearance of corrosion products at the crevices where the corrosive agents entered. Corrosion may appear at the external or internal faying (closely joined) surfaces, but it is usually more prevalent on external areas. More advanced corrosive attack causes skin buckling and eventual spot-weld fracture. Maintenance personnel should detect skin buckling in its early stages by sighting along spot-welded seams or by using a straightedge.

Piano-Type Hinges

Figure 4-26 shows the effect of corrosion on the piano hinges used on aircraft. These are prime spots for corrosion to develop due to the dissimilar metal contact between the steel pin and aluminum hinge tangs. They also natural traps for dirt, salt, and moisture. When used on access doors and plates, these hinges tend to freeze in place because they are opened only during periodic inspections. While inspecting for corrosion of these hinges, maintenance personnel should lubricate the hinge and move the hinge back and forth several times to ensure complete penetration of the lubricant.

RECOGNIZING AND ELIMINATING CORROSION

One of the problems you will have as a maintenance crew member is recognizing and combating corrosion on different materials. The following paragraphs include brief descriptions of typical corrosion product characteristics that are normally found on the materials used in aircraft construction. Also included are the normal procedures for their elimination and prevention. Treating internal corrosion of equipment requires a trained technician, and is normally accomplished at the intermediate-maintenance level. The materials found in avionic equipment, such as gold, silver, tin, solder, and copper alloys, are prone to many forms of corrosion. The treatment for corrosion involving these materials can be found in NAVAIR 16-l-540. When in-depth information is needed about structural corrosion, refer to NAVAIR 01-1A-509. Table 4-2 identifies the

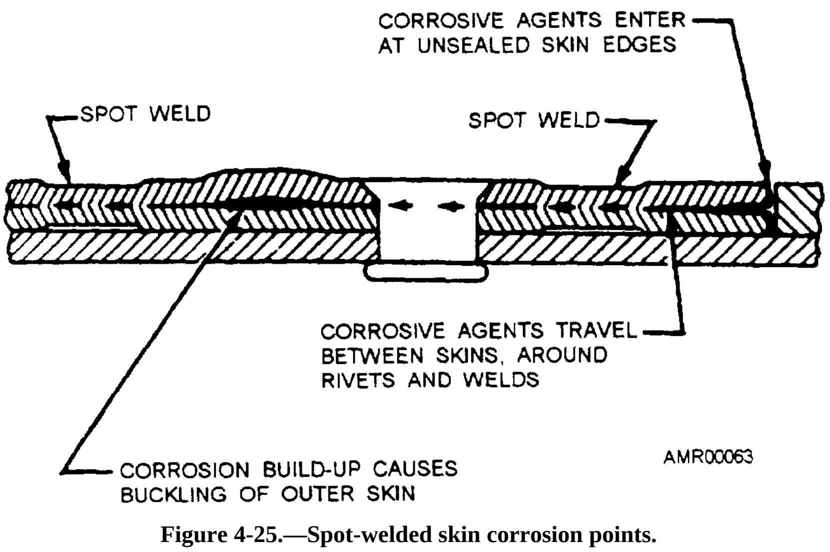


Figure 4-25.—Spot-welded skin corrosion points.

Table 4-2.—Corrosion of Metals—Nature and Appearance of Corrosion Products

ALLOY	TYPE OF ATTACK TO WHICH ALLOY IS SUSCEPTIBLE	APPEARANCE OF CORROSION PRODUCT
Aluminum Alloy	Surface pitting, intergranular, exfoliation, stress corrosion, fatigue cracking and fretting.	White to gray powder.
Titanium Alloy	Highly corrosion resistant. Extended or repeated contact with chlorinated solvents may result in degradation of the metal's structural properties.	No visible corrosion products at low temperature. Colored surface oxides develop above 700°F.
Magnesium Alloy	Highly susceptible to pitting.	White powder snowlike mounds and white spots on the surface.
Carbon and Low-Alloy Steel	Surface oxidation and pitting, surface and intergranular.	Reddish-brown oxide (Rust).
Stainless Steel (300-400 series)	Crevice/concentration cell corrosion; some pitting in marine environments; corrosion cracking; intergranular corrosion (300 series) and surface corrosion (400 series).	Rough surface; sometimes a red, brown, or black stain.
Nickel-base Alloy (Inconel, Monel)	Generally has good corrosion-resistant qualities; susceptible to pitting in seawater.	Green powdery deposit.
Copper-base Alloy Brass, Bronze	Surface and intergranular corrosion.	Blue or blue-green powdery deposit.
Cadmium (protective plating for steel)	Good corrosion resistance. Will cause embrittlement if not properly applied.	White powdery deposit to brown/black mottling of the surface.
Chromium (wear-resistant plating for steel)	Subject to pitting in chloride environments.	Chromium being cathodic to steel, does not corrode itself, but promotes rusting of steel where pits occur in the coating.
Silver	Will tarnish in presence of sulfur.	Brown to black film.
Gold	Highly corrosion resistant.	Deposits cause darkening of reflective surfaces.
Tin	Subject to whisker growth.	Whiskerlike deposits.

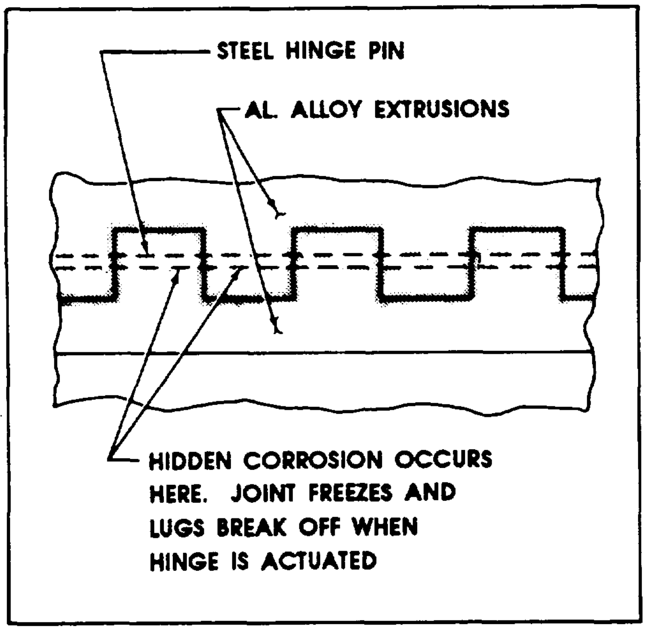
nature and appearance of corrosion products found on the metals used in aircraft construction.

Iron and Steel

Possibly the best known and the most easily recognized form of metals corrosion is the familiar reddish-colored iron rust. When iron and its alloys corrode, dark iron oxide coatings usually form first. These coatings, such as heat scale on steel sheet stock, may protect iron surfaces. However, if enough oxygen and moisture are present, the iron oxide is soon converted to hydrated ferric oxide, commonly known as iron rust. Iron and steel are used in avionic equipment as component leads, magnetic shields, transformer cores, racks, and general hardware. Steel and iron hardware used in aircraft construction is usually plated with nickel, tin, or cadmium.

Aluminum

Aluminum and its alloys are used many places in aircraft construction, including ejection seats, chassis



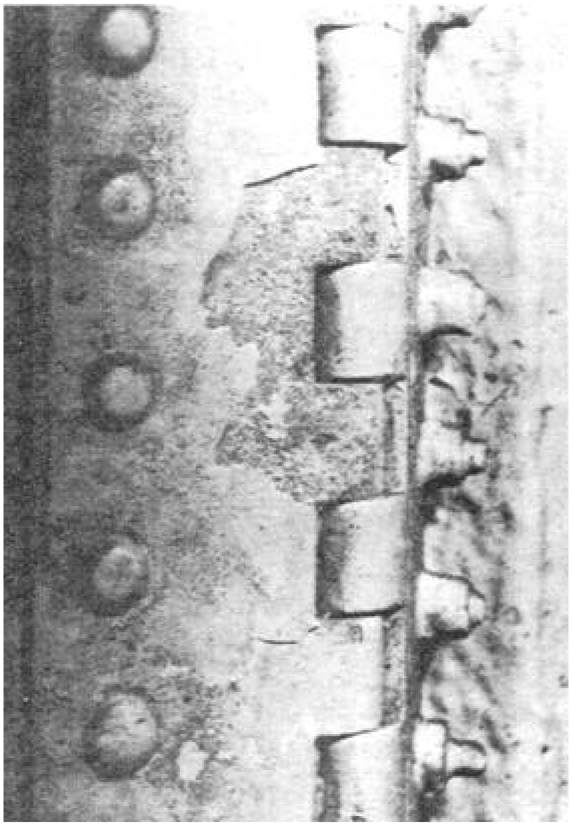


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Figure 4-26.—Hinge corrosion points.

structures in avionic equipment, and the skin of the aircraft. Because of its wide use, you must be able to recognize and take the proper corrective action whenever corrosion is detected or suspected.

Aluminum and its alloys are subject to a wide range of corrosive attack, varying from general etching of the surfaces to penetrating attacks along the internal grain boundaries of the metal. The corrosion products (fig. 4-27) appear as white-to-gray powdery deposits that have greater volume than the original metal. In its early stages, aluminum corrosion is evident as a general etching, pitting, or roughness of the surface. The surface attack progresses quite slowly at first; however, the attack will accelerate if the corroding material is not given immediate attention.

Paint coatings mask evidence of corrosion, but because the corrosion products have a greater volume, corrosion will show up as blisters, flakes, chips, lumps, or other irregularities in the paint coating. Often, white or gray streaks of corrosion products become readily apparent at breaks in the paint film. Maintenance personnel should investigate such signs further to determine the extent that corrosion has progressed.

There are three types of aluminum surfaces insofar as corrosion removal is concerned. They are clad, anodized, and exfoliated aluminum surfaces.

Clad Aluminum Surfaces. Pure aluminum has considerable corrosion resistance compared to aluminum alloys. but it has little or no structural strength. An extremely thin sheet of pure aluminum laminated onto each side of an aluminum alloy sheet improves the corrosion resistance with little impairment of strength. The trade name of this aluminum laminate, as originated by the Aluminum Company of America, is Alcad. From this trade name the adjective clad and the verb cladding have been derived. An example of clad aluminum is the surface of unpainted aircraft. Not all aircraft sheet aluminum is clad, especially those alloy sheets from which small brackets, gussets, and fittings are made. The pure aluminum is very soft, and fabrication processes would severely damage or destroy the clad surfaces.

To remove corrosion from clad surfaces, the corroded areas should be hand polished with MIL-P-6888 metal polish. It effectively removes stains and produces a high-gloss, lasting polish on unpainted clad surfaces. During the polishing operation, you should take care to avoid mechanical

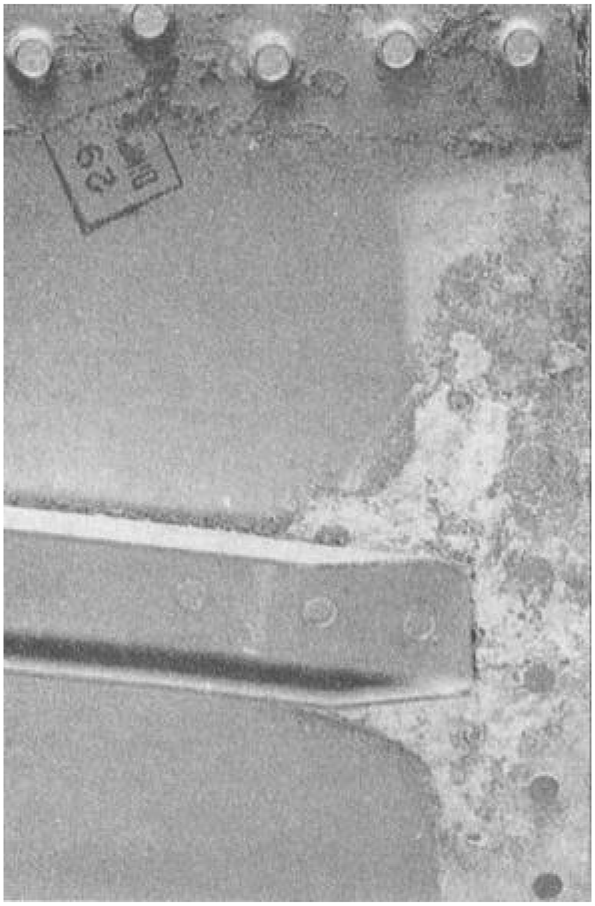

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Figure 4-27.—Aluminum corrosion products.

removal of the protective clad layer and exposure of the more susceptible, but stronger, aluminum alloy base.

If there is any superficial corrosion present, you should treat it by wiping down the surface with an inhibitive material, such as the Chemical Surface Films for Aluminum Alloy, available under specification MIL-C-81706.

Anodized Aluminum Surfaces. Nonclad aluminum alloys are the primary type of aluminum used on naval aircraft. Anodizing is the most common surface treatment of nonclad aluminum alloy surfaces. In anodizing aluminum alloys, the alloy sheet or casting is the positive pole in an electrolytic bath in which an oxidizing agent produces an aluminum oxide film on the metal surface. This aluminum oxide is naturally protective, and anodizing merely increases the thickness and density of the natural oxide film. When this coating is damaged in service, it can only be partially restored by chemical surface treatments. Therefore, when processing anodized surfaces, including corrosion removal, you should avoid destruction of the oxide film.

Aluminum wool (nylon webbing impregnated with aluminum oxide abrasive) or fiber bristle brushes are the approved tools for cleaning anodized surfaces. The use of steel wool, steel wire brushes, or harsh abrasive materials on aluminum surfaces is prohibited. A buffed or wire brush finish produced by any means is also prohibited. Otherwise, anodized surfaces are treated in much the same manner as other aluminum finishes.

Exfoliated Surfaces. As previously described, exfoliation is a separation along the grain boundaries of metal and is caused by intergranular corrosion. More severe procedures must be used when intergranular corrosion is present. All corrosion products and visible delaminated metal layers must be removed by mechanical means to determine the extent of destruction and to evaluate the remaining structural strength of the component. Maintenance personnel use metal scrapers, rotary tiles, and other tools to assure that all corrosion products are removed and that only structurally sound aluminum remains. Maintenance personnel should inspect the area with a 5- to 10-power magnifying glass or use a dye penetrant to determine if all unsound metal and corrosion products have been removed. When all corrosion products have been removed, maintenance personnel should blend or smooth out any rough edges, even if it involves the removal of more metal. Grinding, where required, is best done by using abrasive nylon wheels into which tiny particles of aluminum oxide abrasives have been impregnated. Chemical treatment of exposed surfaces is applied in the same manner as any other aluminum surface. An aeronautical engineer should evaluate any loss of structural strength in critical areas. This is particularly true if the damage exceeds the permissible limits established in the structural repair manual for the aircraft model involved.

Magnesium

Magnesium and its alloys have limited use in aircraft structural construction. However, they are used extensively throughout avionic systems as antennas, structures, chassis, supports, and frames. Magnesium, without a protective coating, is highly susceptible to corrosion when exposed to marine environments. Magnesium forms a strong anodic galvanic cell with every other metal and is ALWAYS the one attacked. Magnesium is subject to direct acid attack, deep pitting, stress corrosion, intergranular, and galvanic corrosion.

Corrosion of magnesium or its alloys forms white, powdery, snowlike mounds. The deposits tend to raise slightly. and the corrosion spreads rapidly. When magnesium corrosion is detected, it requires immediate attention or the corrosion will spread throughout the entire structure. Magnesium corrosion reprotection involves the maximum removal of corrosion products, the partial restoration of surface coatings by chemical treatment, and a reapplication of protective coatings. After maintenance personnel clean the surface and strip the paint, (if any,) they break loose and remove as much of the corrosion products as possible. They do this by using a pneumatic drill with an abrasive wheel or a Vacu-Blast Dry Honing Machine with glass beads. Steel wire brushes. Carborundum™ abrasives, or steel-cutting tools should NOT be used. After corrosion removal, maintenance personnel treat the surface with specification MIL-M-3171 (type VI) chemical treatment solution, as outlined in the NAVAIR 01-1A-509. Then restore the protective paint film.

If extensive removal of corrosion products from a structural casting was involved, a decision from a structural engineer may be necessary to evaluate the adequacy of the structural strength remaining. Structural repair manuals for the aircraft models involved usually include tolerance limits for dimensions of critical structural members. They should be referred to if any question of safety of flight is involved.

Copper and Copper Alloys

Copper and its alloys are generally corrosion resistant, although the products of corrosive attack on copper are commonly known. Sometimes copper or copper-alloy surfaces will tarnish to a dull gray-green color, and the surface may still be smooth. This discoloration is the result of the formation of a fine-grained, copper oxide crust called "patina." The patina, in itself, offers good protection for the underlying metal in ordinary situations. However, exposure of copper and copper alloys to moisture or salt spray causes the formation of blue or green salts, indicating active corrosion. These salts form over the patina since this crust is not totally moistureproof. Copper alloys used in aircraft have a cadmium-plated finish to prevent surface straining and decay.

Copper and copper-based alloys are used in avionic systems as contacts, springs, connectors, printed circuit board runs, and wires. Copper and copper-based alloys (brass and bronze) are resistant to atmospheric corrosion. However, copper is cathodic to iron, steel, aluminum, and magnesium when in electrical contact with these metals.

Maintenance personnel can remove corrosion products by using a pneumatic drill with an abrasive wheel or, as an alternate method, a typewriter eraser (ZZ-E-661. type I or III), depending upon the situation. Copper and copper alloys used in avionic equipment are not usually painted.

Cadmium and Zinc

Cadmium is used as a coating to protect the part to which it is applied. It also provides a compatible surface when the part is in contact with other materials. The cadmium plate supplies sacrificial protection to the underlying metal because of its greater activity. That is, during the time it is protecting the base metal, the cadmium is intentionally being consumed. It functions in the same way that an active magnesium rod inserted in the water system protects the piping of a hot-water heater. The cadmium becomes anodic and is attacked first, leaving the base metal free of corrosion. Zinc coatings are used for the same purpose, but to a lesser extent in aircraft. Attack is evident by white-to-brown-to-black mottling of the cadmium surfaces. These indications DO NOT indicate decay of the base metal and should NEVER be removed for appearance sake alone. Until the characteristic colors peculiar to corrosion of the base metal appear, no steps should be taken,

Cadmium is usually used on bolts as a sacrificial metal to protect the base metal. Zinc is used in avionic/electronic equipment for the same general purpose.

Maintenance personne1 remove corrosion products by rubbing lightly with stainless steel wool, abrasive impregnated webbing, or 320-grit or finer aluminum oxide abrasive paper. They do not remove the undamaged cadmium plate adjacent to the corroded area; this will reduce the amount of protection for the underlying base metal. Wire brushes are not used on cadmium-plated surfaces since they will remove more plating than corrosion. After removing corrosion products from cadmium-plated surfaces, maintenance personnel apply a protective coating to retard the corrosive attack.

Nickel and Chromium Alloys

Nickel and chromium alloys are also used as protective agents in the form of electroplated coatings. Also, they are used as alloying constituents with iron in stainless steels, such as the wear surfaces of aircraft struts. Nickel and chromium plates protect by forming a physical, noncorrosive barrier over the steel. Electroplated coatings, particularly chromium on steel, are slightly porous, and corrosion eventually starts at these pores or pin holes unless a supplementary coating is applied and maintained.

Titanium

Titanium is often used in engine exhaust areas. Titanium is a highly corrosion-resistant metal. However, it can greatly accelerate corrosion of dissimilar metal coupled to it. Insulation between titanium and other metals is necessary to prevent dissimilar metal attack on the other metal. Maintenance personnel must frequently inspect such areas to make sure that insulation failure has not allowed corrosion to begin.

Q59. What publication should you refer to for information about structural corrosion?

Q60. Hydrated ferric oxide is commonly known as what kind of corrosion?

Q61. What are the three types of aluminum surfaces insofar as corrosion removal is concerned?

Q62. How should you remove corrosion from clad aluminum surfaces?

Q63. What is the primary type of aluminum used on naval aircraft?

Q64. What are the approved tools for cleaning anodized aluminum surfaces?

Q65. Who should evaluate any loss of structural strength in critical areas of an aircraft?

Q66. What manual should you refer to for tolerance limits for dimensions of critical structural members?

Q67. Copper and copper-based alloys are used in avionic systems for what purpose?

Q68. Where is titanium most often used on a aircraft?

CORROSION REMOVAL AND TREATMENT

LEARNING OBJECTIVE: Describe the methods of removing and treating corrosion.

Once corrosion is detected, a specific and immediate program for corrective treatment is required. A complete treatment involves paint removal and cleaning of all corroded areas, removal of corrosion products, restoration of protective, surface-treatment films, and immediate application of protective coating and paint finishes. Each type of corrosion has its own peculiarities and requires special treatment. Corrosion should always be removed by the mildest means available.

CORROSION REMOVAL

Before starting any corrosion removal, you must conduct an inspection and evaluation of the suspected area. When you inspect an aircraft or a particular area of an aircraft for corrosion, you should follow the steps listed below.

1. Clean the area thoroughly.

2. If an area is suspected of having corrosion, visually inspect the area by using a magnifying glass.

3. To preclude metal damage, remove paint chemically from areas suspected of having underlying hidden corrosion. Use abrasive paint removal techniques only when corrosive products are observed.

4. After removing the paint, use a magnifying glass to determine the extent of the damage, especially if there is evidence of corrosion on critical parts. Corrosion cracks must be detected as early as possible.

5. Refer to the applicable structural repair manual (SRM) or MIM for damage limits. Metal loss damage is accumulative. When assessing corrosion damage, consider prior metal loss, including areas on the opposite side of the part. Propellers and helicopter blades have critical balance requirements. Refer to the propeller and blade manuals that apply for the evaluation and repair limits of corrosion, erosion, and abrasive damage.

After the aircraft or aircraft part has been inspected, the extent of the corrosion damage must be correctly evaluated. The severity of corrosion damage is grouped into the following categories:

Light corrosion. This type of damage is defined as a protective coating that is scarred or etched by light surface corrosion. characterized by discolorization and pitting to a depth of approximately, 1-mil (0.001 inch) maximum. This type of damage can normally be removed by light hand sanding.

Moderate corrosion. This looks like light corrosion except that there may be some blisters or evidence of scaling and flaking of the coating or paint system. The pitting depths may be as deep as 10 mils (0.010 inch). This type of damage is normally removed by extensive hand sanding or light mechanical sanding.

Severe corrosion. This type of corrosion has a general appearance that may be similar to moderate corrosion with severe intergranular corrosion, blistering exfoliation, scaling, or flaking. The pitting depths are deeper than 10 mils (0.010 inch). This damage must be removed by extensive mechanical sanding and grinding.

Repairable damage. When corrosion damage exceeds the limits of the applicable MIM or SRM, it is classified as repairable damage. The use of the affected part may be continued after repair at a cognizant field activity (CFA).

Nonrepairable damage. When corrosion damage exceeds the established repair limits and requires replacement of the affected parts or special depot-level repair, it is classified as nonrepairable damage.

MECHANICAL CORROSION REMOVAL

The most effective mechanical methods of removing corrosion with the least removal of the metal are vapor blasting, soft-grit blasting, and dry, vacuum blasting. For use on assembled aircraft, a portable unit, such as the VACU-Blast Dry Honing Machine, is the most desirable.

VACU-Blast Dry Honer

The VACU-Blast Dry Honing Machine is a portable, air-operated, self-contained, lightweight unit that uses the dry vacuum return system. Dry honing is the only approved blasting method of removing corrosion on assembled aircraft. With this machine, the work is visible, and metal removal can be held to closer limits. The machine is air-operated, and can be used in shore-based or shipboard operations.

The dry honing machine (fig. 4-28) is composed of the following principal components mounted on a two-wheel carriage assembly:

A hose rack and storage compartment is provided on the front of the dry honing machine for storage of hoses, brushes, and accessories.

The dry honing machine can cause damage to aircraft components and systems if used improperly. Small quantities of abrasives will escape from the blast nozzle during normal use; therefore, the equipment must not be used where the abrasives may contaminate systems or components. The following are precautions you should use when working with this machine:

- Do not use on engines, gearboxes, or other oil lubricating systems.
- Do not use on fuel, hydraulic, or oxygen system components.
- Mask all vent susceptible systems when blasting near them to prevent possible contamination.
- Use only on exterior surfaces or parts that have been removed from the airframe to prevent possible contamination of interior areas.
- Do not use on airframe skins or structural parts that are exposed to more than 500°F in service.
- Do not blast Metallite or honeycomb panels.

Q69. What must you do before starting corrosion removal?

Q70. How should you remove moderate corrosion?

Q71. What is the most desirable method of mechanical corrosion removal?

Abrasive Wheel

An abrasive wheel can be used to remove severe corrosion (intergranular or exfoliation) on thick metal. The abrasive wheel is composed of nonwoven nylon, resin reinforced. The wheel is mounted on a mandrel assembly and driven by a pneumatic drill motor. Eye protection must be worn when an abrasive wheel is operated.

CAUTION

After removal of exfoliation corrosion by abrasive wheel, VACU-Blast area with glass beads to ensure removal of all corrosion. Failure to do so will result in the formation of tiny bubbles or flakes.

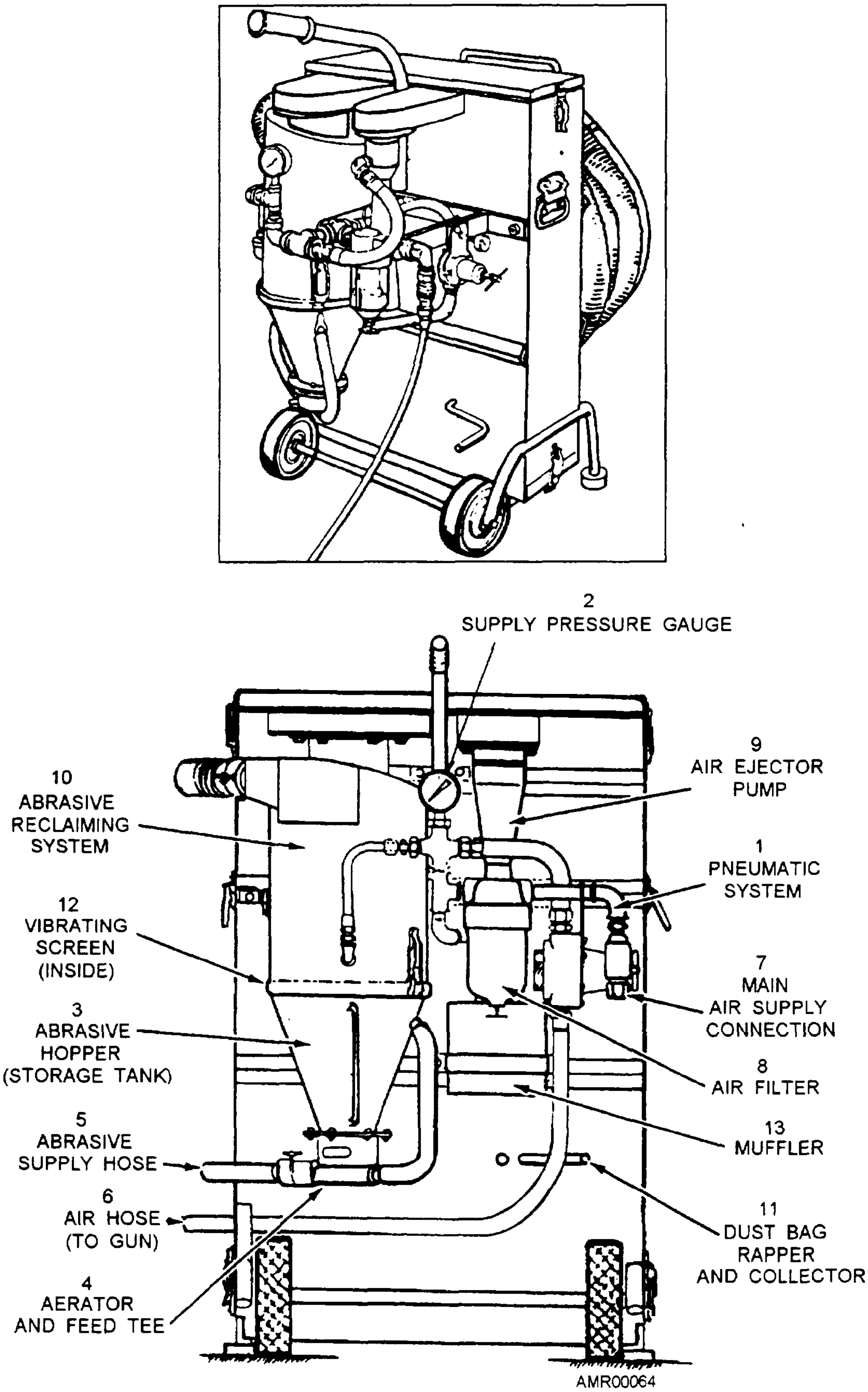


Figure 4-28.—VACU-Blast dry honing machine.

SUPPORT EQUIPMENT (SE) CORROSION REMOVAL AND SURFACE PREPARATION

The following text discusses surface preparation as well as mechanical and chemical paint and corrosion removal methods for SE. They are listed in order from the most effective or preferred to the least effective and not preferred. Each SE maintenance station develops the procedures for operating surface preparation equipment according to the applicable MIMs.

The key to achieving a successful, long-lasting coating system lies in good bonding between coating and metallic surfaces of SE. Paint will not bond to a surface that is poorly prepared. Dirt, oil, grease, corrosion by-products, moisture, and other contaminants prevent complete contact between paint and base metal. In addition, a metallic surface must be roughened to enable the paint system to bond to the surface. This roughened or anchor pattern can be produced by mechanical means or by chemical etchings.

You should remove corrosion, scale, and old paint from SE by the least destructive method. Where simple touch-up painting is required. feather the edges of existing sound paint with light sanding to provide an anchor for the touch-up paint.

You must apply the initial paint to SE as soon as possible following surface preparation. A prolonged lapse in time between surface preparation and painting allows corrosion to form on the prepared surface. This corrosion will cause later coating system failure.

REMOVING DIRT, OIL, AND GREASE

The first step in surface preparation is the removal of dirt, salt, lubricants. hydraulic oil, and other surface contaminants from SE. When grease and oil are present during abrasive blasting, grinding, or wire brushing, they will spread out over the treated surface and disrupt the coating bond. The cleaning method that you use depends on the type of soil, its extent, and the available cleaning equipment. Detergent cleaning, solvent cleaning, emulsifiable solvent cleaning, and acid cleaning are cleaning or degreasing methods.

Detergents and solvents are highly effective in attacking and dissolving grease and oil on metal surfaces of SE. Most solvents can be either applied by vapor degreasing equipment or by wiping. Solvents are specially useful for cleaning small parts and spot-cleaning jobs. Disadvantages of degreasers lie in their toxicity and flammability. Many solvents are particularly dangerous when used on oxygen service equipment.

Emulsifiable solvent (solvents suspended in a gelatinlike medium) cleaning is an effective cleaning method for removing heavy oil, grease, wax, and other contaminants of SE.

Acid cleaning combines the forces of oil solvents and detergent cleaners in removing grease, oil, light rust, and other contaminants. The method is useful on the heavy steel structures of SE where surface etching is required. This cleaning method requires a thorough rinse with clean water.

MECHANICAL CORROSION REMOVAL ON SUPPORT EQUIPMENT (SE)

Abrasive or grit blasting is the preferred surface preparation method for many of the components of SE. Such blasting provides the clean anchor pattern needed by most coating systems. Wet abrasive blasting is preferred to dry blasting. Before blasting, disassemble the components according to the applicable technical manual. Mask all areas that should not be blasted, such as tapped holes, key ways, machined surfaces, reflectors, lights, and gauges.

When using abrasive blasting equipment, you must wear protective clothing, face shield or safety goggles, and a respirator.

Wet Abrasive Blasting

Water blasting is a technique that requires high-pressure producing equipment. It involves the propelling of water and blasting beads. The water blast method removes surface chemical contaminants, deteriorated paint, grease accumulations, oil, and mastic materials from SE.

NOTE: You must use Sodium Nitrite MIL-S-24521 during the abrasive process to prevent flash rusting.

The Hydroblaster or other water blast machines can be dangerous if not handled properly or with sufficient safeguards.

Dry Abrasive Blasting

Dry abrasive blasting involves propelling abrasive particles against the metallic surface by either high-pressure air or spinning paddle wheel. The striking of these particles against the metal abrades away deteriorated paint and scale. Many abrasive blast machines (portable dry-honing machines) reclaim used grit by cleaning and sifting out dirt, scale, and damaged grit. (See figure 4-28.) Grit that has been recycled after use on steel, brass, bronze, or copper-nickel should not be used on aluminum. Do not blast aluminum with steel or copper slag or chilled iron grit. Table 4-3 lists some common abrasive materials and grit sizes.

CLEANING SURFACES WITH POWER TOOLS

Power tool cleaning includes devices that impact the metallic surface with an abrasive substance or mechanical object. Impact tools, powered wire brushes, and disk sanders are common power tool cleaners for SE.

Impact tools, such as the needle gun (pneumatic descaler), provide a rapid means for removing rust and old paint from metal surfaces of SE. These tools must NEVER be used on aluminum.

A wire brush powered pneumatically or by electric motor is a method for removing small amounts of paint and rust from SE. Often, the overextended use of a wire brush results in a metal surface that is polished to a glossy appearance. A polished surface produces a poor anchor pattern for paint bonding.

Usually, electric or pneumatic disk sanders abrade the metal surface of SE with coarse to fine grit. When used with the needle gun, the disk sander can produce a uniform anchor pattern of very closely spaced scratches.

WARNING

When using abrasive power hand tools, you must wear eye protection to prevent serious injury.

Q72. What is the preferred surface preparation method for many of the components of support equipment?

Q73. What should you use during the abrasive process to prevent flash rusting?

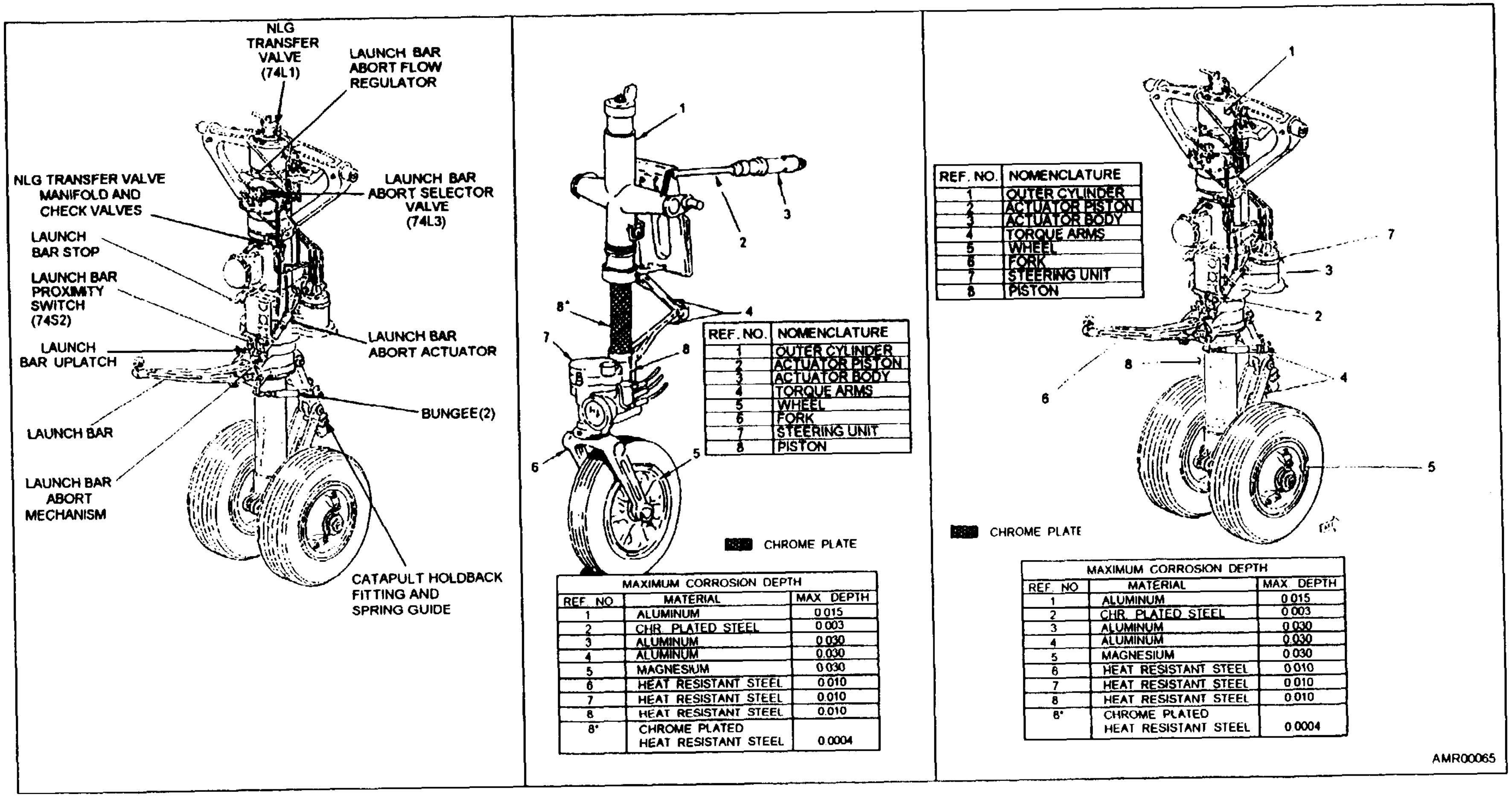
CORROSION DAMAGE LIMITS

LEARNING OBJECTIVE: Recognize the limits in removing corrosion damage.

Corrosion damage limits refer to the amount of metal that may be removed from a corroded part without impairing the strength and function of the part. When removing corrosion, maintenance personnel must be very careful not to remove more of the metal than is necessary to ensure complete removal of corrosion. Figure 4-29 shows the maximum corrosion depths allowed on the various components of the nose landing gear. When damage exceeds the limits specified in the SRM or the corrosion control section of the MIM, the affected part must be replaced if structural repair of the damage is not possible.

Table 4-3.—Recommended Grit for Steel and Aluminum

TYPE OF METAL BLASTED	RECYCLING			NON-RECYCLING		
	GRIT	SAE MESH	PRES PSI	GRIT	SAE MESH	PRES PSI
Steel	Angular silica	20/40	75	Silica sand	20/40	75
	Sand			Crushed garnet	20/40	75
	Crushed garnet	20/40	75			
	Aluminum oxide	20/50	50			
Aluminum	Silica sand	20/40	75	Silica sand	20/40	75
	Aluminum oxide	20/50	50	Crushed garnet	20/40	75
	Crushed garnet	20/40	75			



REF. NO.	NOMENCLATURE
1	OUTER CYLINDER
2	ACTUATOR PISTON
3	ACTUATOR BODY
4	TORQUE ARMS
5	WHEEL
6	FORK
7	STEERING UNIT
8	PISTON

MAXIMUM CORROSION DEPTH

REF. NO	MATERIAL	MAX DEPTH
1	ALUMINUM	0.015
2	CHR. PLATED STEEL	0.003
3	ALUMINUM	0.030
4	ALUMINUM	0.030
5	MAGNESIUM	0.030
6	HEAT RESISTANT STEEL	0.010
7	HEAT RESISTANT STEEL	0.010
8	HEAT RESISTANT STEEL	0.010
8*	CHROME PLATED HEAT RESISTANT STEEL	0.0004

Figure 4-29.—Nose gear maximum corrosion depths.

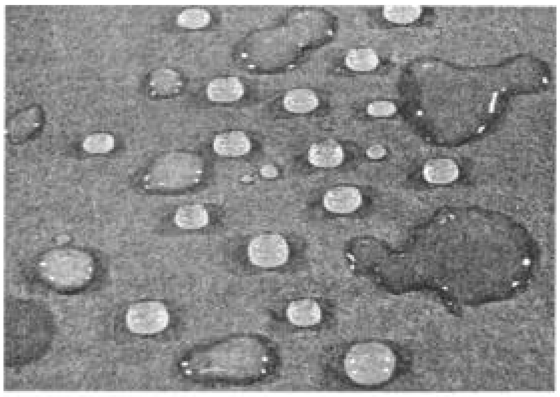
Q74. Information regarding corrosion removal limitations can be found in what publications?

CHEMICAL SURFACE TREATMENT

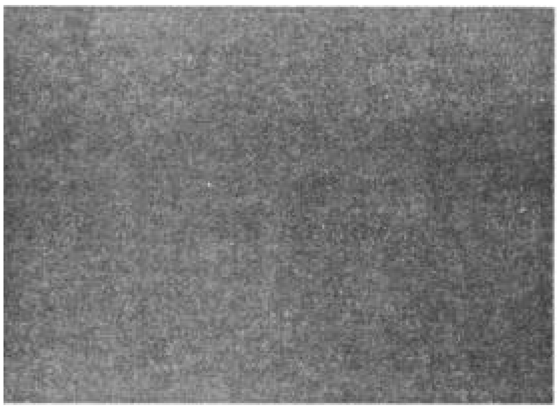
LEARNING OBJECTIVE: Define the purpose for chemically preparing a surface for priming and painting.

Chemical conversion coatings increase a surface's resistance to corrosion and improve paint bonding on the surface.

The metal to be treated must be cleaned to a water breakfree surface (fig. 4-30). Metal surfaces not free of water breaks must be recleaned with a solution of 1 part MIL-C-43616 or MIL-C-25769 aircraft cleaning compound to 16 parts of water, and then rinsed with water. Surfaces that have been waxed, particularly with silicone wax, may require special cleaning. After cleaning and removal of surface oxides, aluminum should be treated with MIL-C-81706 and magnesium with MIL-M-3171, type VI, chemical conversion coating material.



WITH WATER BREAKS



WATER BREAK FREE

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Figure 4-30.—Water break comparison.

CAUTION

Personnel must wear protective clothing, rubber gloves, and chemical goggles when using a solution of MIL-C-81706 and MIL-M-3171 or serious injury could result.

Apply these chemical conversion coatings immediately after cleaning the surface to a water breakfree surface and while the surface is still wet. Apply these coatings by brush, nonatomizing spray, or sponge stick moistener. The sponge stick moistener is particularly useful for small areas.

Soluble salt residues that remain on the surface after treatment accelerate corrosion and can cause blistering of paint finishes. Thus, complete rinsing with fresh water following the chemical treatment is very important. Flush the chemical with free-flowing water only. Allow the chemical conversion coated surface to dry (usually 30 minutes) before painting. Do NOT wipe the surface with a damp cloth or brush, as this will degrade or remove the chemical conversion coating.

Chemical conversion coatings are often damaged during aircraft maintenance, or they may be contaminated by grease, oil, or other foreign matter. Therefore, the treated surface should be painted soon after treating to obtain the best results.

CHEMICAL CONVERSION OF ALUMINUM ALLOYS

The procedure to be used for the chemical conversion of aluminum alloys is as follows: Apply the conversion coating material, MIL-C-81706 (Form V [powdered] is preferred, Form III [premixed] is an alternate), until you obtain a golden iridescent color. Immediately rinse the chemical from the surface with large amounts of fresh water when you obtain the proper color conversion. This rinsing stops the chemical action and minimizes solution entrapment. Failure to rinse may accelerate corrosion and reduce paint bonding. If a long period of contact before rinsing is allowed, a powdery, coated surface may be the result.

CHEMICAL CONVERSION OF MAGNESIUM ALLOYS

The procedure for the chemical conversion of magnesium alloys is as follows: Apply the conversion coating material MIL-M-3171 until you obtain a greenish-brown or brass-colored yellow color. For a proper conversion coating, keep the surface wet with the specified solution until you obtain the desired color. Rinse with fresh water. Remove any excess conversion coating solution that collects into pools within the aircraft.

Some magnesium parts in later model aircraft were originally protected by a proprietary (held under patent) electrolytic process. One process is identified by the brown to mottled gray appearance of the unpainted surface. Another process will appear as a green to grayish-green color. These coatings are thicker than those applied by the immersion or brush method, such as MIL-M-3171. The electrolytic finish cannot be restored in the field. Therefore, when failure of the coating occurs, you should remove corrosion and touch up the bare magnesium with MIL-M-3171 chemical treatment solution. You should minimize removal of the electrolytic coatings, as they afford greater protection than the replacement coatings.

Q75. What is the purpose for chemically treating a surface for painting?

Q76. When failure of the coating occurs, you should remove corrosion and touch up the bare magnesium with what chemical treatment solution?

AIRCRAFT PAINTING AND COMPONENT TOUCH-UP

LEARNING OBJECTIVE: Identify the materials used and procedures for painting aircraft.

The amount of paint touch-up done at organizational- and intermediate-level maintenance varies widely. The amount depends upon the activity involved, the availability of facilities, and the area of operations.

The primary objective of any paint finish is the protection of the exposed surface against decay. There are secondary reasons for particular paint schemes. Glare is reduced by nonspecular (not mirrorlike) coatings. White or light-colored, high-gloss finishes reduce heat absorption. Camouflage, high visibility, or special identification marking requirements are met by various paint schemes. REPAINTING SHOULD NOT BE DONE FOR APPEARANCE SAKE ONLY. A faded or stained but well-bonded paint finish is better than a fresh touch-up treatment applied over dirt, corrosion products, or other contaminants.

Complete refinishing (particularly under field conditions) should be restricted to those areas where existing paint finishes have degraded until they fail to perform their protective function. However, the organizational and intermediate levels of maintenance should evaluate maintenance and repair of paint finishes. This should be done at the time of aircraft receipt and through constant surveillance and maintenance of finishes during an aircraft's service tour. Maintenance also should make final recommendations for refinishing an aircraft when the aircraft is scheduled for standard depot-level maintenance (SDLM).

General safety precautions should be followed when you paint and when you use special types of paints. These precautions include the following:

- No eating, drinking, or smoking is allowed in areas where paint or solvent is being used.
- Prolonged breathing of vapors from organic solvent is dangerous. Prolonged skin contact with organic solvents or materials containing organic solvents can have a toxic effect on the affected skin area.

PAINT REMOVAL

Paint removal operations at the organizational and intermediate levels of maintenance are usually confined to small areas, or possibly a whole panel. In all cases, the procedures outlined in the MIM that applies should be observed. General stripping procedures are contained in NAVAIR 01-1A-509.

Materials

All paint removers are toxic and caustic; therefore, both personnel and material safety precautions must be observed in their use. Personnel should wear eye protection, gloves, and a rubber apron.

Paint remover, specification MIL-R-81294, is an epoxy paint remover for use in the field. This remover will strip acrylic and epoxy finishes. Acrylic windows, plastic surfaces, and rubber products are damaged by this material. This material should not be stocked in large quantities as it ages rapidly, degrading the results of stripping action. This paint remover must NOT be used to remove paint from composite materials.

Procedures and Precautions

The stripping procedures described below are general in nature. When stripping any aircraft surface, you should consult the applicable MIM for the specific procedures to be used. Stripping should be accomplished outside whenever possible. If you must strip aircraft surfaces in a hangar or other enclosure, you should make sure you have adequate ventilation. You should adhere to the following general procedures and precautions during stripping operations:

> **CAUTION**
>
> Before cleaning and stripping, make sure that the aircraft is properly grounded. This will dissipate any static electricity produced by the cleaning and stripping operations.

- Where the paint remover may contact adhesives, mask all seals, joints, skin laps, and bonded joints by using the approved tapes and papers.
- Apply the stripper liberally. Completely cover the surface with a thick layer of stripper with a paint or acid brush. The stripper should not be spread in a thin coat like paint because it will not loosen paint sufficiently for removal, and the remover may dry on the surface of the metal. This would require it to be reapplied.
- Allow the stripper to remain on the surface long enough for it to wrinkle and lift the paint. This may be from 10 to 40 minutes, depending upon temperature, humidity, and the condition of the paint coat being removed. Reapply paint remover as necessary in the areas where paint remains tight or where the material has dried.
- Remove loosened paint and residual paint remover by washing and scrubbing the surface with fresh water, fiber scrapers, bristle brushes, and rags. If water spray is available, you should use a low-to-medium pressure stream of water. Apply it directly to the surface while scrubbing the surface.
- After a thorough cleaning, you should remove masking materials and clean any residual paint from the surface.
- Rinse with water and clean the area with aircraft cleaning compound (1 part MIL-C-85570 to 9 parts water) to remove paint remover residue.

Flap Brush

Paint can be mechanically removed with a flap brush. The brush consists of many nonwoven, nonmetallic, nylon flaps bonded to a fiber core. The brush assembly (fig. 4-31) is made up of a flap brush, flanges, and mandrel. Use a NO LOAD 3200 rpm pneumatic drill motor to power the brush. Do not use a flap brush that is worn down to within 2 inches from the center of the hub. Continued use beyond this limit may cause gouging due to loss of flexibility of the fiber. When you use a flap brush, apply minimum pressure to remove the most paint and the least metal. Excessive pressure will cause some paints to melt, gum up, and streak around the area being worked. For safe and efficient operation, the direction of rotation is indicated by an arrow imprinted on the inside of the core. Wear eye protection when operating a flap brush, and consult your maintenance instruction manuals for limitations on corrosion removal.

Q77. What is the primary purpose of any paint finish?

Q78. When using paint removers, you should wear what type of protective clothing?

Q79. What safety precaution must be taken before cleaning and stripping old finishes on aircraft?

Q80. What type of motor should you use to power a flap brush?

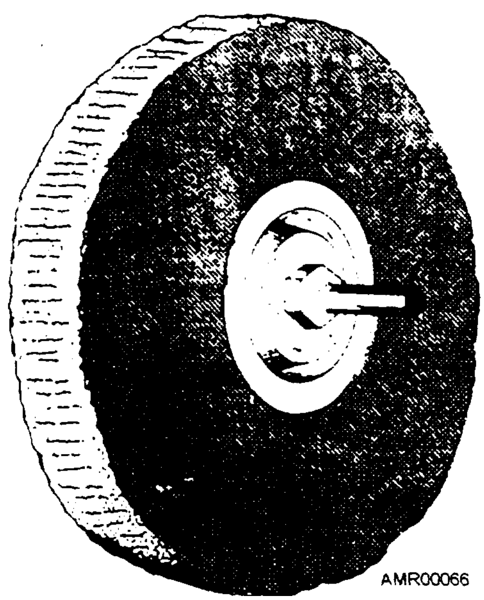

Figure 4-31.—Flap brush and mandrel.

SURFACE PREPARATION

The effectiveness of any paint finish and its bond to the surface depends upon the careful preparation of the damaged surface before touch-up. The touch-up paint should overlap onto the existing good paint finish. The touch-up materials will not bond to glossy finishes, so the finishes must be prepared. Also, any edges of the existing film will show through the overlap unless they are smoothed out.

To break the gloss of existing finishes and to feather (smooth out) the edges for overlap, you should scuff sand by using 240 or 320 grit aluminum oxide cloth. After sanding, use a water rinse to remove the abrasive residues.

You should remove any loosened seam sealants in the area to be touched up and replace them as necessary. Also, resecure any loose rubber seals by using the type of adhesive specified in the applicable MIM.

Then outline the area to be painted with tape and masking paper, as shown in figure 4-32. This protects the adjoining surfaces from overspraying and unwanted paint buildup.

TOUCH-UP PROCEDURES

A standardized paint system for O- and I-level painting and paint touch-up is presented in NAVAIR 01-1A-509.

Standardized exterior paint touch-up systems for organizational and intermediate levels of maintenance consist of an epoxy primer (MIL-P-23377, type I or type II, as applicable) overcoated with aliphatic polyurethane (MIL-C-85285). Paint systems are identified by a decal or stencil located on the right side of the aft fuselage.

Standardized interior paint touch-up systems for O- and I-level maintenance consist of zinc chromate primer (TT-P-1757). Paint materials that are within their original shelf life or within an extended shelf life are preferred. However, if materials are beyond shelf life date, test them by using a small sample of scrap aluminum.

The following paragraphs furnish the basic information for identifying and applying the standard touch-up paint systems. Complete information on the types and applications of aircraft paint systems is contained in NAVAIR 01-1A-509.

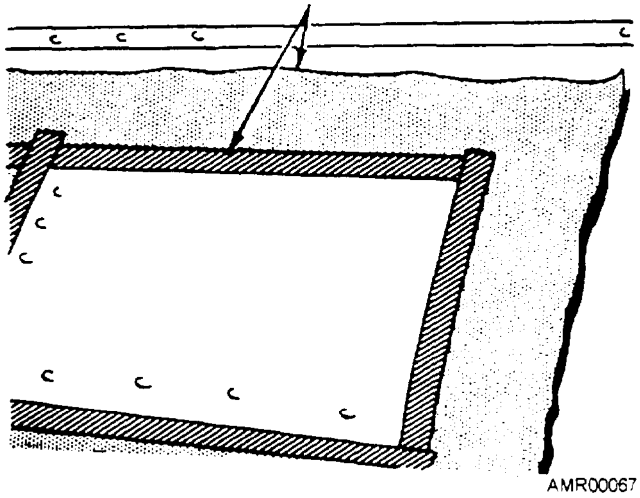

Figure 4-32.—Masking before paint touch-up.

Epoxy-Polyamide Primer (MIL-P-23377)

The epoxy-polyamide primer is supplied as a two-part kit. Each part must be stirred or shaken thoroughly and separately before they are mixed together. One part contains the pigment particles in an epoxy vehicle. The other part is composed of a clear polyamide solution that functions as a hardener for the epoxy solution. This primer is supplied by various manufacturers. You should mix only as much primer as needed. The storage life of the primer is limited after it is mixed to the amount that can be used in 4 hours. Refer to NAVAIR 01-1A-509 for specifics on mixing these two components.

Zinc Chromate Primer

Zinc chromate primer (TT-P-1757) is a general-purpose, interior, protective coating for metal surfaces. Depending upon the location, zinc chromate primer may or may not require a topcoat. Zinc chromate primer is easy to apply or remove as it is a single component. There is no thinning required for brush or roller application however, for spray application, thin this primer with MIL-T-81772. Do not use zinc chromate primer on exterior aircraft surfaces, including wheel wells and wing butts, and in areas that are exposed to temperatures exceeding 175°F (79.4°C).

Polyurethane Finish Systems

You must have a physical examination before you can work with polyurethane coatings. Also, you must have periodic physicals during the time you are working with these coatings.

There are two types of polyurethane systems used on naval aircraft-the aliphatic type (used in MIL-C-85285 and TT-P-2756 polyurethane paints) and the aromatic type (used in polyurethane, rain erosion-resistant coatings, MIL-C-85322). These materials present no special hazard to health when cured (dried), but they require special precautions during preparation, application, and curing due to the isocyanate vapors produced. The isocyanates vapors can produce significant irritation to the skin, eyes, and respiratory tract even in very small concentrations. They also may induce allergic sensitization of personnel exposed to their vapors and mists produced during spray applications. Aliphatic polyurethane. MIL-C-85285, is the standard, general-purpose, exterior, protective coating for aircraft surfaces.

The polyurethane finish comes in kits that consist of a two-component material resin and a catalyst. The touch-up kits are prethinned and ready for use when they are mixed according to the instructions in the kit. Use aliphatic polyurethane over epoxy polyamide primer and for touch-up and insignia markings over polyurethane paint systems only.

Acrylic Lacquer

Acrylic lacquer (gloss and camouflage) MIL-L-81352 is the preferred topcoat material for aircraft markings that identify the reporting custodian and for propeller safety stripes.

Enamel Finishes

Most enamel finishes used on aircraft surfaces are baked finishes that cannot be touched up with the same materials in the field. Minor damage to conventional enamel finishes ordinarily used on engine housings is repaired by touching up with epoxy topcoat material or air-drying enamel.

Elastomeric Rain Erosion-Resistant Coating (MIL-C-85322)

Elastomeric coatings are used as a coating system to protect exterior laminated plastic parts of high-speed aircraft, missiles, and helicopter rotary blades from rain erosion in flight. They offer good resistance to weather and aromatic fuels in addition to rain erosion. Excellent bonding is obtained after a 7-day drying period.

Repair to these coatings in the field is not practical due to this long curing time. Kits are available for repair of coatings where limited touch-up is required. These kits contain a primer, neoprene topcoat, and antistatic coating. If the radome or leading edge coatings are in bad condition, they should be stripped completely and recoated with epoxy primer and acrylic topcoat as a temporary measure. If schedules and conditions permit adequate curing of elastomeric coatings, the original coatings may be replaced.

The repair kits are normally bought as an open purchase to ensure that fresh materials are available. Since heat accelerates aging, repair kits should be stored in a cool place or refrigerated. Stripping of fiber glass surfaces should be done according to current maintenance instructions. Elastomeric coatings are toxic and flammable, and must be used with care.

PAINTING EQUIPMENT (SPRAY GUNS)

The spray gun atomizes the material to be sprayed, and the operator directs and controls the spray pattern through manipulation and minor adjustments of the spray gun. Spray guns are usually classed as either a suction-feed or pressure-feed type. The type of spray gun can be determined by two methods-by the type of container used to hold the paint material and by the method in which the paint is drawn through the air cap assembly. For information on the types of spray guns, refer to NAVAIR 01-1A-509.

Suction-Feed Type

The suction-feed spray gun is designed for small jobs. The container for the paint is connected to the spray gun by a quick-disconnect fitting, as shown in figure 4-33. The capacity of this container is approximately 1 quart. The fluid tip of this spray gun protrudes through the air cap, as shown in figure 4-34. The air pressure rushing by the fluid tip causes a low-pressure area in front of the tip. This causes paint to be drawn up through the fluid tip, where it is atomized outside the cap by the air pressure.

Pressure-Feed Type

The pressure-feed spray gun is designed for use on large jobs where a large amount of spray material is to be used. With this type of spray gun, the material is supplied to the gun through a hose from a pressurized tank. This spray gun produces a high volume of spray material metered at a low air pressure. This type of

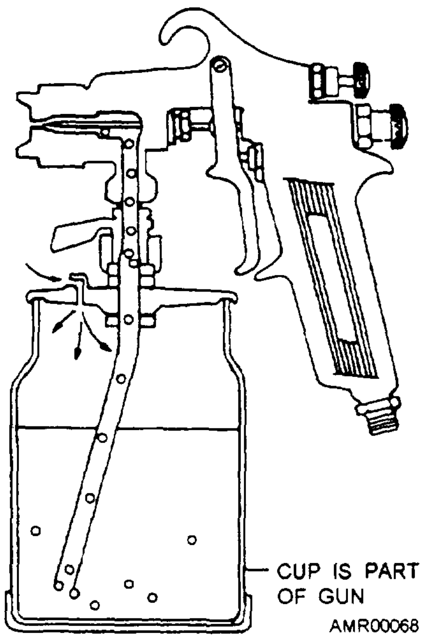

Figure 4-33.—Suction-feed type of spray gun.

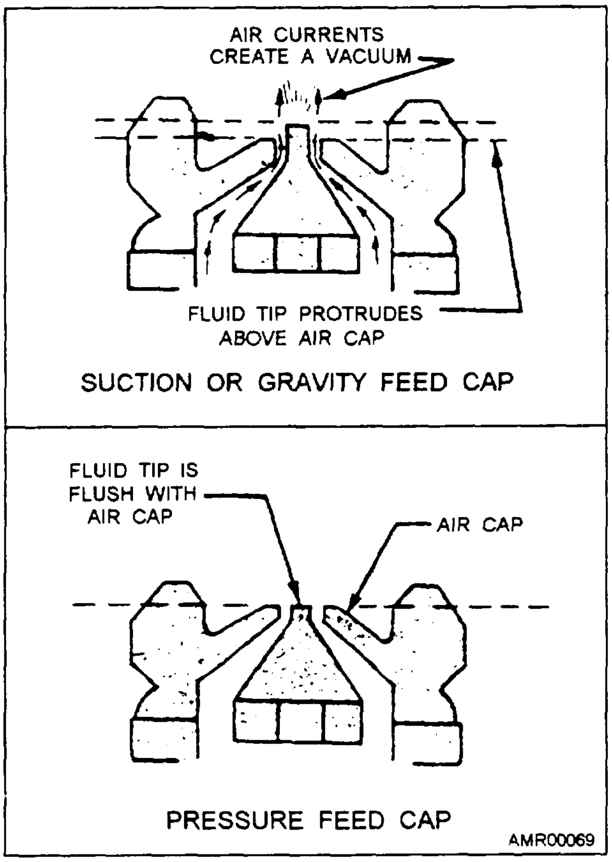

Figure 4-34.—Suction and pressure fluid tips and air caps.

spray equipment eliminates evaporation of the volatile substances of the mixture before they strike the surface because the paint and air are mixed internally. Thus, a wetter coating is applied.

SEALANTS

> **CAUTION**
>
> Many of the sealants discussed in this section may be flammable or produce toxic vapors. When materials designated as flammable are used, ail sources of ignition must be at least 50 feet away from the work location. Toxic vapors are produced by the evaporation of solvents or the chemical reaction that takes place in the curing sealants. When sealants are used in a confined space, such as a fuel cell, fuselage, wing section, or table or bench operation, adequate local exhaust ventilation must be used. This will reduce the vapors below the maximum allowable concentration and keep them at that level until repairs have been completed. Personnel must NOT eat or smoke when they work with sealants.

Sealants are used to prevent the movement of liquid or gas from one point to another. They are used in an aircraft to maintain pressurization in cabin areas, to retain fuel in storage areas, to achieve exterior surface aerodynamic smoothness, and to weatherproof the airframe. Sealants are used in general repair work in the field and for maintenance and restoration of seam integrity in critical areas if structural damage or the use of paint removers has loosened existing sealants.

Conditions surrounding the requirements for use of sealants govern the type of sealants to be used. Some sealants are exposed to extremely high or low temperatures. Other sealants are in contact with fuels, lubricants, and so forth. Therefore, sealants are supplied in different consistencies and rates of cure. The basic types of sealants are classified in three general categories-pliable sealants, drying sealants, and curing sealants.

Pliable sealants are called "one-part" sealants and are ready for use as packaged. They are solids and change little, if any, during or after application. Solvent is not used in this type of sealant. Therefore, drying is not necessary; and except for normal aging, they remain virtually the same as when first packaged, neither hardening nor shrinking. They bond well to metal, glass, and plastic surfaces. Pliable sealants are used around high-usage access panels and doors, and in areas where pressurized cavities must be maintained.

Drying sealants set and cure by evaporation of the solvent. The solvents in these sealants provide the desired consistency for application. Consistency or hardness may change when this type of sealant dries, depending upon the amount of solvent it contains. Shrinkage is a consideration when these sealants are used. Shrinkage occurs upon drying. The degree of shrinkage depends on the proportion of solvents.

Catalyst-cured sealants have advantages over drying sealants. They are transformed from a fluid or semifluid state into a solid mass by chemical reaction of physical change rather than by evaporation of a solvent. A chemical catalyst of accelerator is added and thoroughly mixed just before sealant applications. Heat may or may not be used to speed up the curing process. When a catalyst is used, accurate proportioning and thorough mixing of the two components are very important to assure a complete and even cure.

Application of Sealants

Application of sealants varies according to time element, tools required, and the method of application. However, the following restrictions apply to all sealant applications:

- Sealants should be used within the approximate application time limits specified by the sealant manufacturer.
- Sealants should not be applied to metal that is colder than 70°F. Better bonding is obtained and the applied sealant will have less tendency to flow out of place while curing if the metal is warmed to a temperature of 90°F to 100°F before the sealant is applied.
- Sealants should be discarded immediately when they become too stiff to apply or work readily. Stiff or partially cured sealants do not wet the surface to which they are applied as well as fresh material. This causes uneven bonding.
- Sealants should not be used for close-fitting (faying) surface applications unless they have just been removed from refrigerated storage or freshly mixed.

Brushes, dipping, injection guns, spatulas, and spray guns are the methods used to apply sealants. Figure 4-35 shows (black areas) where sealant is applied to protect some of the most corrosion-prone areas on an F-14 aircraft. The sealant is applied by using the spray, spatula, and brush methods.

Sealant MIL-S-81733, type III, is the sealant used most extensively for spray application. If type III sealant cannot be procured, sealant MIL-S-8802, class A, may be used by thinning it to a sprayable consistency by the addition of the correct solvent.

When an aircraft is pressure sealed, the sealing materials should be applied as a continuous bead, film, or fillet over the sealed area. Air bubbles, voids, metal chips, or oily contamination prevent an effective seal. Therefore, the success of the sealing operation depends upon the cleanliness of the area and the careful application of the sealant materials. There are various methods of pressure-sealing joints and seams in aircraft. The applicable SRM will specify the method to be used in each application.

The sealing of a faying surface is done by brush. The contacting surfaces are coated with the specified sealant. Application of the sealant should be made immediately before the parts are fastened together. Careful planning of work and equipment are necessary so faying surface seals on large assemblies may be closed within the application time limit of the sealant. Once the sealant has been applied, the parts must be joined, the bolts torqued, and the rivets driven all within the application time limit.

When insulating tape has been installed between the faying surfaces to prevent contact of dissimilar metals, pressure sealing should be done by fillet sealing. In fillet sealing, the sealant is spread along the seam with a sealant injection gun in about 3-foot increments. Before proceeding to the next increment, the applied portion of the fillet is worked in with a sealant spatula or tool (fig. 4-36). This working of the sealant is done to till in all voids in the seam and to eliminate most air bubbles. The care used in working out the air bubbles determines the leakfree service life of the sealant. After the sealant has cured to a tackfree condition, the fillet should be inspected for remaining air bubbles. These air bubbles should be opened and filled with sealant. When a heavy fillet is required, the fillet should be applied in layers. The top layer should fair with the metal.

Injection sealing is the pressure filling of openings or voids with a sealant injection gun. The sealant is forced into the opening until it emerges from the opposite side. Voids and cavities are filled by starting with the nozzle of the sealant injection gun at the bottom of the space and tilling as the nozzle is

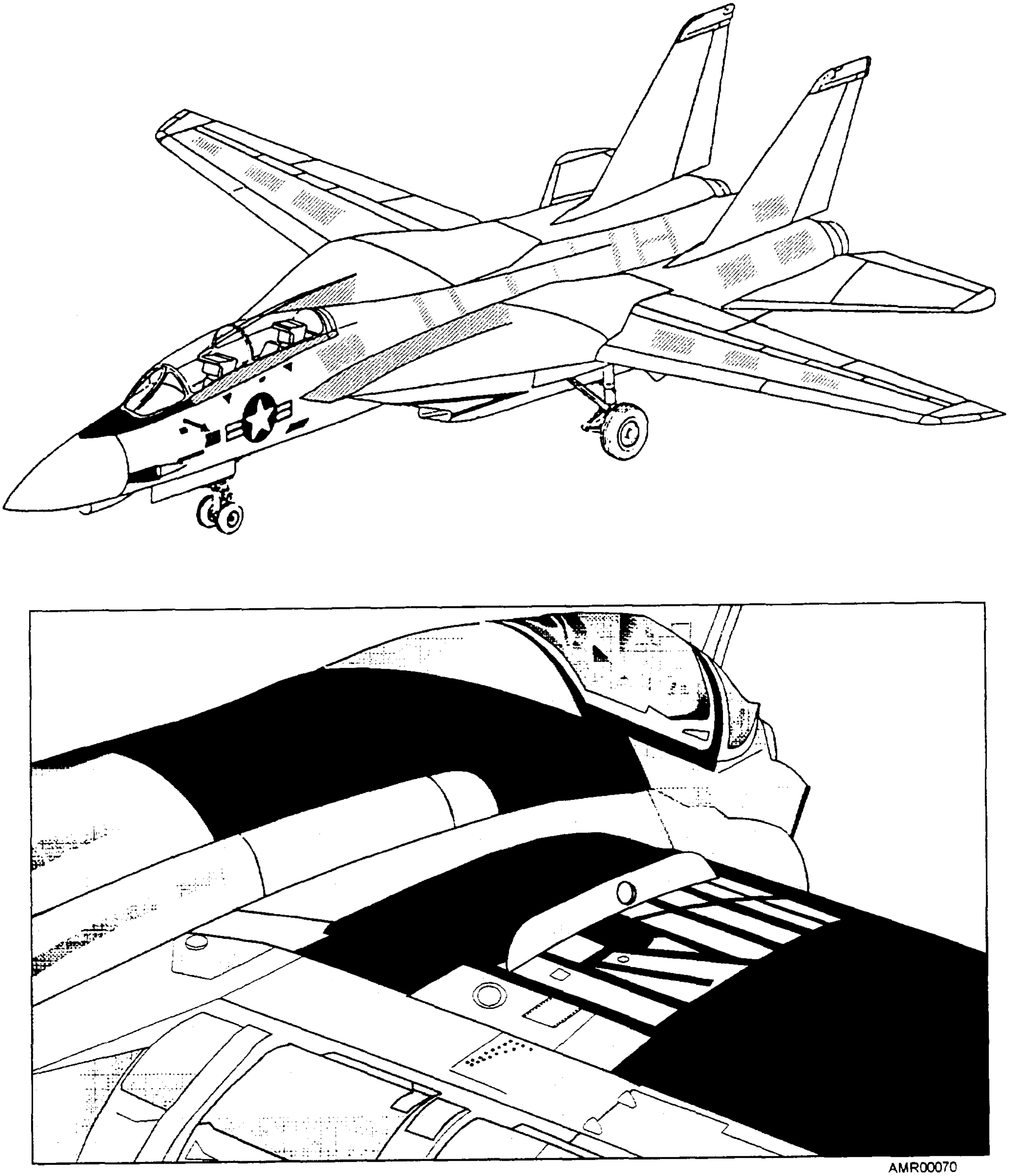

Figure 4-35.—Sealant applied to aircraft exterior surfaces.

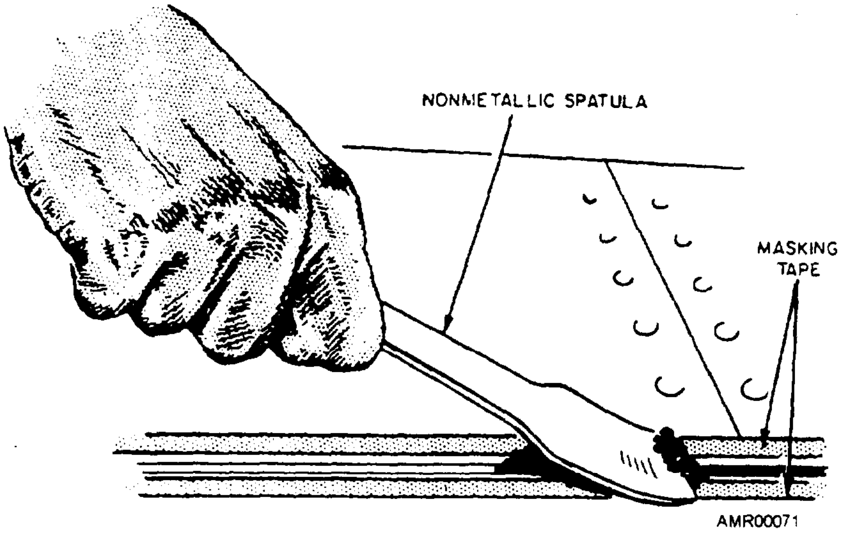

Figure 4-36.—Applying sealant.

withdrawn. An example of injection sealing is the caulking of a leaking fuel cell.

Fasteners, such as rivets, Rivnuts, screws, and small bolts, should have a brush coat of sealant over the protruding portion on the pressure side. Washers should have a brush coat of sealant on both sides. Split-type grommets should have sealant brushed into the split before installation. After installation, fillets should be applied to both the base of the grommet and the protruding tube on the pressure side.

Sealing Compound (MIL-S-8802). MIL-S-8802 is a temperature-resistant (-65°F to +250°F), two-component, synthetic rubber compound used for sealing and repairing fuel tanks and fuel-cell cavities. It is produced in three classifications.

Class	Use
A	For brushing application
B	For extrusion gun and spatula application
C	For faying surface sealing

Sealing Compound (MIL-S-81733). MIL-S-81733 is an accelerated, room-temperature curing, synthetic rubber compound. It is used in sealing metal components on weapons and aircraft systems for protection against corrosion. This sealant contains a corrosion inhibitor. Figure 4-37 shows MIL-S-81733 sealing compound used to seal an antenna. It comes in four types.

Type	Applied by	Maximum application time in hours
I	Brush	1/2
	Dip	2
II	Extrusion	1/2
	Gun	2
	Spatula	4
III	Spray gun	1
IV	Brush or Spatula	12 to 48

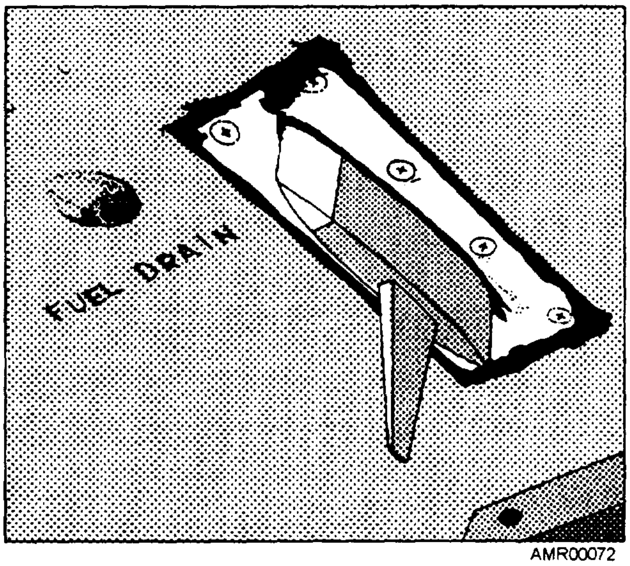

Figure 4-37.—Typical fleet antenna sealing application.

Sealing Compound (MIL-S-8516). MIL-S-8516 is an accelerated, synthetic, rubber sealing compound used for sealing low-voltage electrical connectors, wiring. and other electrical equipment against moisture and corrosion where temperatures do not exceed 200°F. This sealant has very good resistance to fuels, oils, grease, water, and humidity. However, it is NOT authorized for use in engine bays, keel areas, or areas adjacent to bleed-air ducts. It is manufactured in kit form and comes in sizes from 2.5 ounces to 1 quart. MIL-S-8516 is available in three classes with different curing times.

Class	Curing time in hours
1	24
2	48
3	72

Silicone Rubber Sealant (MIL-S-23586). Room temperature vulcanizing (RTV), silicone rubber sealant is used for sealing small electrical connectors and electrical components that are located in areas where the temperatures are between 200°F and 450°F. This sealant has good resistance to weathering, moisture, and withstands ozone. RTV silicone rubber sealant is available in two types, both used for the same purposes. The two types are type II, class 2, grade A, and type 1, class 1, grade B- 1. Type II, class 2, grade A contains cure volatiles and should be used only in well-ventilated areas.

Adhesive Silicon Sealant (MIL-A-46146). Also known as 3145 RTV. A noncorrosive sealant for use on sensitive metals and avionics equipment in areas that are exposed to temperatures between 250°F and 350°F. This sealant comes in 3-, 8-, and 12-ounce tubes.

CAUTION

Many RTV silicone sealants contain an acetic acid curing agent. These sealants, when in contact with metal, cause rapid corrosion. RTV sealants that contain acetic acid are NOT authorized for use on electronic or electrical circuits. They may be identified by the emission of a vinegar odor while in a liquid or curing state.

Q81. Complete information on the types and applications of aircraft paint systems is contained in what publication?

Q82. After it is mixed, the storage life of epoxy-polyamide primer is limited to the amount that can be used in how many hours?

Q83. What is the standard, general-purpose, exterior protective coating for aircraft surfaces?

Q84. What are the two classes of spray guns?

Q85. When flammable materials are used, all sources of ignition must be at least how far away from the work location?

SUMMARY

This chapter identifies the manuals and procedures used to detect and combat corrosion on naval aircraft and support equipment. It identifies the types and causes of corrosion. Familiarize yourself with types and uses of cleaning materials and the procedures and materials for preservation and depreservation. This is vital information.

ANSWERS TO REVIEW QUESTIONS

A1. *Corrosion reduces the strength and changes the mechanical characteristics of the material.*

A2. *Corrosion control.*

A3. *Weight-to-strength ratio.*

A4. *Metal corrosion,*

A5. *Protection from corrosive environments.*

A6. *Electron flow is established from the cathode to the anode.*

A7. *They speed the corrosion process.*

A8. *Thick sections are more likely to have variations in their composition, particularly if heat-treated during fabrication.*

A9. *Moisture is the single largest contributor to avionics corrosion.*

A10. *NAVAIR 01-1A-509.*

A11. *NAVAIR 16-1-540 provides information on cleaning and corrosion prevention and control of avionics equipment.*

A12. *NAVAIR 15-01-500, Preservation Of Naval Aircraft.*

A13. *General uses for cements, sealants, and coatings.*

A14. *A period of intensive care should follow the deployment cycle to bring the aircraft back up to standard.*

A15. *A good corrosion prevention program.*

A16. *Every 14 days.*

A17. *a. Aircraft is exposed to corrosive fire-extinguishing materials.*

b. Spilled electrolyte and corrosive deposits are found around battery terminals and battery area.

c. The aircraft has been exposed to significant amounts of salt water.

d. Salt deposits, relief tube waste, or other contaminants are apparent.

e. Fungus growth is apparent.

f. Chemical, biological, or radiological contaminants are detected.

A18. *They must be cleaned or wiped down.*

A19. *Flammability and toxicity*

A20. *Inhaling toxic vapors can seriously affect the brain and central nervous system.*

A21. *They must be kept in specially marked containers.*

A22. *In a separate building or-flammable liquids storeroom.*

A23. *It is applied by spraying, dipping, brushing, or wiping.*

A24. *1,1,1-trichloroethane.*

A25. a. Apply by wiping or scrubbing the affected area with an acid brush or toothbrush.

b. Air dry or oven dry as applicable.

c. Do not use on acrylic plastics or acrylic conformal coatings.

d. Do not use on unsealed aluminum electrolytic capacitors. Damage may result to end caps and cause leakage.

A26. Silicon carbide paper because it is sharp and the individual grains can penetrate steel surfaces.

A27. Because it conforms to the surface, the applicator allows easier application of a constant scrubbing pressure on curved skin panels.

A28. MIL-C-85570.

A29. Select the proper cleaning agent for the method of cleaning chosen.

A30. Upward and outward.

A31. Dry-cleaning solvent.

A32. It is not oxygen compatible and will cause explosion or fire.

A33. A polyethylene sheet, polyethylene-coated cloth, or metal foil barrier materials.

A34. The maintenance instructions manual (MIM).

A35 NAVAIR 01-1A-509.

A36. Level I—Short term, up to 60 days.

Level II—60 days to 1 year.

Level III—Long term, 1 to 8 years.

A37 Level I preservation.

A38. All three. Grades I, IL and IV.

A39. Antifriction bearings, shock-strut pistons, and other bright metal surfaces.

A40. It is used when a water-displacing, low temperature, lubricating oil is required.

A41. Type III.

A42. Level I.

A43. Ground Support Equipment Cleaning and Corrosion Control, NAVAIR 17-1-125.

A44. Silicone sealant MIL-A-46146, type I, and polysulfide sealant MIL-S-81733 or MIL-S-8802.

A45. Uniform or direct surface attack

A46. Aluminum and magnesium alloys.

A47. White or gray powdery deposit.

A48. Avoid the creation of crevices during repair work.

A49. Intergranular corrosion is an attack on the grain boundaries of alloys under specific conditions.

A50. It is usually the result of faulty design or improper maintenance practices.

A51. Stress induced by press-and-shrink fits and those in rivets and bolts.

A52. Fatigue corrosion is caused by the combined effect of corrosion and stress applied in cycles to a component.

A53. A slight vibration, friction, or slippage between two contacting surfaces that are under stress or heavy load.

A54. Steel, aluminum, and magnesium.

A55. Applicable periodic maintenance information cards (PMICs).

A56. A cathode, an anode, and an electrolyte.

A57 Black paint to prevent glare.

A58. Daily.

A59. NAVAIR 01-1A-509.

A60. Iron rust.

A61. Clad, anodized, and exfoliated.

A62. Hand polish the corroded areas with MIL-P-6888 metal polish.

A63. Nonclad aluminum alloys.

A64. Aluminum wool or fiber bristle brushes.

A65. An aeronautical engineer.

A66. Structural repair manuals for the specific aircraft model.

A67. Contacts, springs, connectors, printed circuit board runs, and wires.

A68. In the engine exhaust areas.

A69. Conduct an inspection and evaluation of the suspected area,

A70. Extensive hand sanding or light mechanical sanding.

A71. VACU-Blast dry honing portable machine.

A72. Abrasive or grit blasting.

A73. Sodium Nitrite MIL-S-24521.

A74. The applicable aircraft Structural Repair Manual (SRM) or the "Corrosion" section of the Maintenance Instruction Manual (MIM)

A75. Chemical conversion coatings increase a surfaces resistance to corrosion and improve paint bonding to the surface.

A76 MIL-M-3171.

A77. The protection of the exposed surfaces against decay.

A78. You should wear eye protection, gloves, and a rubber apron.

A79. Ensure the aircraft is properly grounded.

A80. Use a NO LOAD 3200 rpm pneumatic drill motor.

A81. NAVAIR 01-1A-509.

A82. 4 hours.

A83. Aliphatic polyurethane, MIL-C-85285.

A84. Suction feed and pressure-feed spray guns.

A85. 50 feet.